AN ANALYSIS OF REGULATORY FRAMEWORKS FOR WIRELESS COMMUNICATIONS, SOCIETAL CONCERNS AND RISK: THE CASE OF RADIO FREQUENCY (RF) ALLOCATION AND LICENSING

Thesis agreed for the degree of
Doctor of Philosophy

by

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August 2008

ABSTRACT

This thesis analyses how and why culture and geography influence the allocation and licensing of the radio frequency (RF) spectrum in different nations. Based on a broad study of 235 countries, an inter-disciplinary approach is used to explore regulatory frameworks and attitudes toward risk. In addition, detailed case studies of the UK, France, the US and Ecuador provide deeper insights into the main contrasting regulatory styles.

Three alternative sociological theories are used to analyse and explain the results for both the in-depth and broad brush studies. The Cultural Theory of Mary Douglas and co-workers is first used to categorise countries in terms of perceptual filters. The empirical findings indicate some countries to be apparently exceptional in their behaviour. The theory of Bounded Rationality is used to investigate and explain these apparent irrationalities. Finally, Rational Field Theory shows how beliefs and values guide administrations in their RF regulation.

A number of key factors are found to dominate and patterns emerge. The European RF harmonisation is unique. Following European unification, wireless regulation is divided into two major camps (the EU and the US), which differ in their risk concerns, approach to top-down mandated standards, allocation of RF spectrum to licence-exempt bands and type approval process. The adoption of cellular and TV standards around the world reflects geopolitical and colonial influence. The language of a country is a significant indicator of its analogue TV standard. Interestingly, the longitude of a country to a fair extent defines RF allocation: Africa and West Asia follow Europe, whereas the Americas approximate the US. RF regulation and risk tolerability differ between tropical and non-tropical climates. The collectivised/centralised versus the individualised/market-based rationalities result in different regulatory frameworks and contrasting societal and risk concerns. The success of the top-down European GSM and the bottom-up Wi-Fi standards reveal how the central-planning and market-based approaches have thrived. Attitudes to RF human hazards and spurious emissions levels reveal that the US, Canada and Japan are more tolerant of these risks than Europe. Australia, Canada, New Zealand, UK and USA encourage technological innovation.

A practical benefit of this study is that it will give regulators more freedom to choose a rational RF licensing protocol, by better understanding the possibly self-imposed boundaries of cultural and geographical factors which are currently shaping allocation. Academically, there is utility in undertaking a cultural and geographic analysis of a topic that is mostly the domain of engineering, economic and legal analysts.

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Acknowledgements

The author thanks the 88 multiple observers of 46 countries. Consultation with experts was done through email correspondence and conversations. Especially thanks are due to Alonso Llanos from Ecuador, Jose Cracovski from Argentina, Michel Lemaitre from France and Eliezer Oren from the US for their valuable inputs.

Abbreviations

3G	Third Generation
3GPP	Third Generation Partnership Project
ALARP	As Low As Reasonably Practicable
ANFR	*Agence Nationale des Fréquences*
ANSI	American National Standards Institute
APT	Asia Pacific Telecommunity
ARIB	Association of Radio Industries and Businesses (Japan)
ATSC	Advanced Television Systems Committee (USA)
ATU	African Telecommunications Union
BR	Bounded Rationality
CAATEL	*Comite Andino de Autoridades de Telecomunicaciones* (South America)
CAN	*Comunidad Andina de Naciones* (South America)
CANTO	Caribbean Association of National Telecommunication Organisations
CAPTEF	*Conférence Administrative des Postes et Télécommunications des pays d'Expression Française*
CCIR	*Comité Consultatif International de la Radio* (the former name of ITU-R)
CDMA	Code Division Multiple Access
CEN	*Comité Européen de Normalisation*
CENELEC	*Comité Européen de Normalisation ELECtrotechnique*
CEPT	*Conférence Européenne des Administrations des Postes et des Télécommunications*
CFR	Code of Federal Regulations (USA)
CITEL	*Comisión Interamericana de TELecomunicaciones*

CPP	Calling Party Pays (contrary to cellular Receiving Party Pays, RPP)
CSN	*Comunidad Sudamericana de Naciones*
CT	Cultural Theory
CTO	Commonwealth Telecoms Organisation
dB	deciBel
DECT	Digital European Cordless Telecommunication System
DMB-T	Digital Multimedia Broadcasting – Terrestrial (China)
DVB-H	Digital Video Broadcasting – Handheld (Europe)
DVB-T	Digital Video Broadcasting – Terrestrial (Europe)
EBU	European Broadcasting Union
EC	European Community (subsequently also European Union, EU)
ECC	European Communications Committee
e-Communications	Electronic Communications
EDGE	Enhanced Data rates for Global Evolution
EEC	European Communities Commission
EFTA	European Free Trade Association
EMF	Electro Magnetic Fields
ERO	European Radiocommunications Office
ETSI	European Telecommunications Standards Institute
EU	European Union
FCC	Federal Communications Commission (USA)
FM	Frequency Modulation
FRATEL	*reseau FRAncophone de la régulation des TÉLécommunication*
FTAA	Free Trade Area of the Americas
GDP	Gross Domestic Product
GE89	Regional Agreement for the African TV Broadcasting Area (Geneva 1989)
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	*Groupe Spéciale Mobile;* Global System for Mobile communication
GSO	Geostationary Satellite Orbit
HDTV	High Definition TV
HF	High Frequency (3-30 MHz)
Hz	Hertz (the base unit of frequency)
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ICT	Information and Communication Technologies
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IFC	International Finance Corporation
IIRSA	Initiative for the Integration of South America region
IMF	International Monetary Fund
IMT-2000	International Mobile Telecommunications-2000 (ITU); termed IMT, following the 2007 Radio Assembly RA-07
ISDB-T	Integrated Services Digital Broadcasting- Terrestrial (Japan)
ISM	Industrial Scientific and Medical
ISO	Industrial Organisation for Standardisation
ITU	International Telecommunications Union
ITU-D	ITU- Development Sector
ITU-R	ITU- Radiocommunications Sector
ITU-T	ITU- Telecommunications Sector
LAFTA	Latin American Free Trade Association

LDC	Least Developed Countries
LE	Licence Exempt
MAC	Multiplexed Analogue Components
MERCOSUR	*Mercado Común del Sur* (South America)
NAFTA	North America Free Trade Agreement
NRA	National Regulatory Authority
NRPB	the former UK National Radiological Protection Board
NSO	National Standards Organisations
NTSC	National Television System Committee (USA)
OAS	Organisation of American States
OECD	Organisation for Economic Co-operation and Development
OFDM	Orthogonal Frequency-Division Multiplexing
PAL	Phase Alternation by Line (Germany and UK)
PLC	Power Line Communication
PTT	Postal, Telegraphic and Telecommunications
R&TTE	Radio equipment and Telecommunications Terminal Equipment (EC)
RCC	Regional Commonwealth in the field of Communication (former USSR)
RF	Radio Frequency
RFID	Radio Frequency IDentification
RFT	Rational Field Theory
RLAN	Radio Local Area Network
RMS	Root Mean Square
RR	Radio Regulations (of the ITU)
RRC-06	Regional Radio Conference 2006; also titled GE-06 and Geneva-06 Agreement
SAR	Specific Absorption Rate
SECAM	*SÉquentiel Couleur Avec Mémoire* (Sequential Colour with Memory) (France)
SRD	Short Range Devices
ST61	Regional Agreement for the European Broadcasting Area (Stockholm 1961) (ITU)
T-DAB	Terrestrial Digital Audio Broadcasting (CEPT)
TD-SCDMA	Time Division Synchronous Code Division Multiple Access (China)
TETRA	Trans European Trunked RAdio (ETSI)
TIA	Telecommunications Industry Association (USA)
UHF	Ultra High Frequency (300-3,000 MHz)
UMTS	Universal Mobile Telecommunications System (ETSI)
UWB	Ultra Wide Band
VHF	Very High Frequency (30-300 MHz)
WARC	World Administrative Radio Conference (ITU)
WB	World Bank
WHO	World Health Organization
Wi-Fi	Wireless Fidelity (IEEE)
WRC	World Radio Conference
WTA	Wireless Telegraphy Act
WTO	World Trade Organisation

Introduction

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1 Overview

Wireless rules indicate how a society functions and its decision-making processes; RF (Radio Frequency) thresholds reveal the national risk attitude. The research explains how choices are unnecessarily bound by culture; it contrasts rationalities and RF regulation in the European and American hemispheres. This research breaks new ground by correlating regulation with geography and colonial heritage. Technical wireless regulation is not usually perceived as related to culture, but the research highlights the links and correlations between the two. This dissertation presents 'multiple case studies' on selected countries, as well as a wider reference of all countries.

Suggesting a correlation and explaining the influence of the culture and geographical latitude on RF allocation and licensing is unique. *Cultural Theory*, *Bounded Rationality* and *Rational Field Theory* have never been used before in this context. For the first time research has been carried out to investigate the validity of these sociological theories within the regulatory framework of wireless communications; there is utility in doing so.

The three theories set out a framework for explaining social responses to risk, and the different decision makers' rationalities are highlighted. A comparison of *societal* and *risk concerns* contributes to the debate about the relative cautiousness of the US relative to Europe. This knowledge provides more freedom to regulators around the world in understanding their possibly self-imposed or externally-imposed boundaries and hence having opportunities to break out of them. The cultural and geographical dimensions in analysing RF allocation, licensing and adoption of standards have generally been neglected. The central thrust of the analysis is coming from cultural influences on RF allocation.

The research questions are:

1) *How* and *why* do culture and geography influence RF allocation and licensing?

2) To what extent do sociological theories of risk offer an explanation of the pattern of allocation of the RF spectrum, including licensing and issues of *risk tolerability*?

3) What are the different *rationalities* in RF allocation and licensing?

2 Methodology

2.1 What was Done: the Structure of the Chapters

This section describes how the research for this dissertation has been carried out and how sociological theories have been applied to *case studies* of RF allocation and licensing. This thesis explores ‘how’ and 'why' cultural and geographic attributes shape the regulation and standards of wireless communications; and the focus of the study is on the setting of standards and risk thresholds. Figure 2-1 'The structure of the research' depicts the logical flow of information and ideas, what was done, the integration between the chapters and the empirical and theoretical studies required for answering the research questions. This introductory chapter and the *Literature Review* (chapter 1) serve as groundwork for the empirical and theoretical studies; they introduce the methods and components of the research: *Introduction* presents the methodology, and the essential technical information on RF standards and emission limits; *Literature Review* appraises the current knowledge and primary reports on *regulatory frameworks*, *societal* and *risk concerns*, regulation and theoretical approaches. The empirical survey begins (chapter 2) with *International and Regional Regulatory Frameworks*: the relevant rules of the intergovernmental organisation ITU (International Telecommunications Union), the supranational Europe as represented by the EU[1], international South America and *CAN* (*Comunidad Andina de Naciones*) are explored; quantitative and qualitative data is offered; and the regional agencies are compared. Chapter 3 *Case Studies* proceeds down the regulatory hierarchy to national regulation and standards, looking at the impact of international and regional regulation on national RF standards; the chapter discusses the detailed *regulatory frameworks*, RF licensing and attitudes to risk in European countries (UK and France) and the Americas (the US and Ecuador); the *Case Studies* chapter compares the most influential powers in wireless industry (EU and the US), and the most influential standardisation institutions (European Telecommunications Standards Institute - ETSI and the US Federal Communications Commission - FCC). Chapters 2 and 3 essentially contrast Europe versus the US. The research comprises multiple *case studies* focusing on 'thick' specifics, followed by a 'thin' data collection of all countries. Chapter 4 *Indicators* expands to a comparative survey spanning the entire globe: a cross-national study of wireless regulation, standards and attitudes to risk; the *master-data* is an Appendix of *Indicators.* Chapters 2, 3 and 4 comprise the empirical study: the *regulatory frameworks*, patterns and varieties of wireless standards

[1] "For convenience we refer to institutions of the European Union as 'EU' throughout, though strictly speaking most of the regulatory activity described falls within the narrower European Community jurisdiction" (Hood *et al.* 1999:162).

in the selected regions and countries and around the world; these chapters correlate the adoption of standards with geographic and cultural differences, compare the various agencies and explore national attitudes to risk.

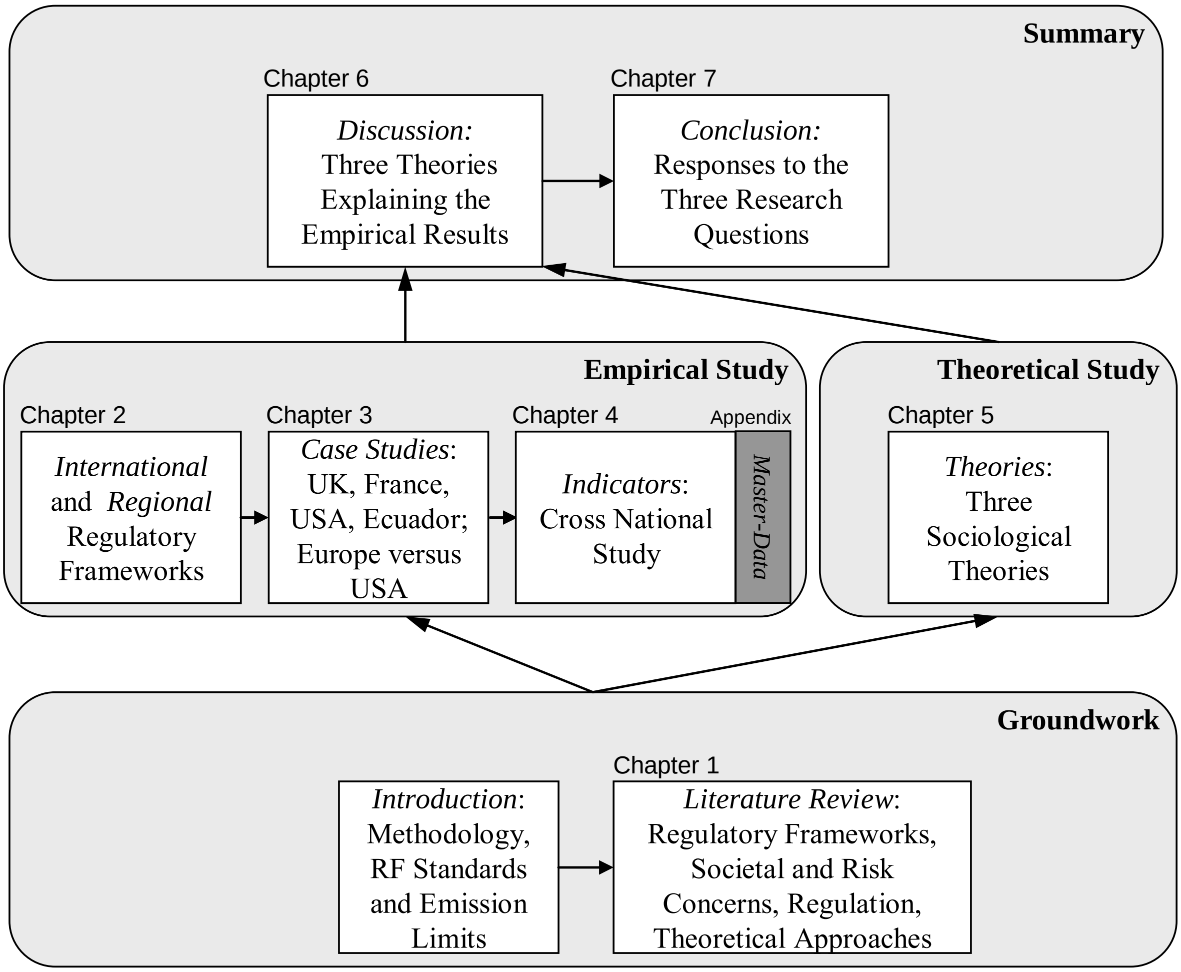

Figure 2-1 The structure of the research

Three contending theories categorise the regions and countries in terms of perceptual filters and distinguish them by *risk tolerability* and different styles of rationality: risk-averse versus risk-seeking and central-planning versus market-based. Chapter 5 *Theories* explores the three sociological theories. Chapters 6 *Discussion* and 7 *Conclusion* evaluate the findings and summarise the research. The empirical and theoretical studies (chapters 2 to 5) lead to chapter 6*; Discussion* explains and interprets systematically the results of the global, regional and national data using the three alternative theories. Chapter 7 *Conclusion* demonstrates the responses to the three research questions and concludes the study. The bibliography, list of external experts (Appendix A) and the *master-data* (Appendix B) are at the end of the thesis.

'Compare and contrast' tables and statistical figures illustrate the empirical data; world and regional maps highlight the findings and depict the exceptional countries (relative to neighbours); schematic models categorise countries and illuminate the discussions; professional templates classify the countries and present philosophical values.

2.2 How it is Done: Multiple *Case Studies*

The comparative method is often treated as a subsidiary version of statistical analysis, in which the important observations to be drawn from the cases are taken on the values of the dependent variable: in this thesis, RF standards and rules. The comparative method is a distinctive approach that offers a rich set of observations, comparing a theory's prediction about causal processes, and may force us to change our views in important ways (Mahoney and Ruesche 2003:411). This method in particular suits the study as it enables observations to be presented systematically, in order to analyse the data, to reach the conclusions and to justify them, using the theories.

The thesis comprises multiple *case studies* (see Robson 2002:183), which illuminate the RF regulatory patterns and exemplify the columns (explanatory and dependent variables) in the *master-data*: the empirical data of all countries. The multiple *case studies* focus on regional and national specifics: *regulatory framework*, *societal concerns* and risk attitudes. The *case studies* indicate detailed, intensive facts about regional agencies and four countries; their national RF allocation and licensing approaches illustrate the global data and help its generalisation and understanding. After examining the countries with a mainly Christian heritage (three developed and one tropical-developing) in Europe and America, the cross-national chapter *Indicators* provides a worldwide perspective to the *case studies*. The statistics illustrate how culture and geography influence RF allocation and licensing; they correlate geography and culture with RF standards, they reveal links between variables and provide significance to the results (the observed values); the statistics also indicate the exceptional countries.

2.3 *Case Studies*: Choice of Regions and States

This research refers to the regional and national *regulatory frameworks* employed as *multiple case studies*. The EU and *CAN* are the regional organisations; the US, UK, France and Ecuador are the selected national administrations.

The EU and the US were chosen because they are the dominant superpowers in e-Communications in the 21st century; their regulations and standards are the most widely-accepted around the world. UK and France have adopted opposite regulatory styles (market-based versus central-planning approach); they differ in their cultural attributes: language, religion and legal origin. There is a further interest in UK and France because of the additional EU *regulatory framework* that adds to (or departs from) their national regulatory approach. Throughout their history the US, UK and France have tried to spread their worldview (and gain more power); it seems that ex-colonies tend to preserve the culture bestowed upon them.

South America can be seen as representing the other continents (such as Africa and Asia) and *CAN* (Bolivia, Colombia, Ecuador and Peru) exemplifies other regional institutions. The relations of intergovernmental *CAN* and South America are compared to supranational EU and Europe. Ecuador is a typical example of a developing country; 134 countries are classed as developing, 49 are least developed and only 48 are developed countries; see the *master-data*[2]. Moreover, Ecuador and *CAN* countries are typical of tropical countries; most of the world: 130 out of 235 countries. The columns of the *master-data* show that Ecuador and *CAN* are near the media: the latitude of Ecuador is **2.0** degrees, the cellular percentage per inhabitant in 2003 is 18.3 %; the average (and standard deviation) values for Bolivia, Colombia, Ecuador and Peru are latitude **8.3** (6.8) degrees and cellular penetration 14.6 (3.1) %; 117 tropical countries (which updated their cellular statistics) are located in latitude **12.7** (6.9) degrees; their average cellular penetration is 19.3 (23.1) % .

2.4 Empirical Data Answers How Culture and Geography are influential

2.4.1 The Statistical Variables

The quantitative study includes an empirical survey of all countries. The study links cultural and geographic factors to RF regulation, and indicates the anomalous countries. The main variables of the *master-data* are geographical and cultural features, international membership, mains electricity (50/60 Hertz), colour TV standard adoption (NTSC, PAL or SECAM) and cellular (GSM, CDMA, UMTS and TETRA) operation. The explanatory variables serve to indicate the clusters of countries, to identify the anomalous countries and to compare *societal concerns* and risk tolerability. The dependent attributes for the research are the adoption of TV and cellular standards, the permitted levels of RF *human hazards* and RF *spurious emissions*.

— Over-the-air analogue TV (in the 20th century), digital TV, and cellular technologies (in the 21st century) are the leading RF services and the most significant wireless applications; therefore, they are repeatedly used throughout the research.

— The RF thresholds are used to compare the *societal* and *risk concerns*; these objective

[2] No data in all the thesis sources (ITU, World-bank UN and CIA), about the remaining 4 South Pacific islands: Christmas, Cocos (Keeling), Norfolk and Pitcairn; it exemplifies a difficulty in collecting data.

records attract much public interest (especially *human hazards*) and reveal the *risk tolerability* and the regulator's type of rationality.

The language, religion and legal origin of a country are elementary cultural attributes; these independent explanatory variables are not *sui generis*. The main independent geographical variables are the continent in which the country lies, and its latitude. The independent factors explain the dependent variables, in order to answer half of the first research question: **how** culture and geography influence RF licensing; for example how language guides the adoption of TV standards, and how latitude influences the cellular penetration rate and the RF *human hazards* limit.

2.4.2 Collection of Data

The author has ensured that the data for the quantitative analysis is as accurate and reliable as possible. The dependent variables are formal and official data provided by the 191 countries of the ITU, World Bank, World Health Organisation (WHO) and international telecommunications institutions. The study is comparative; in order to apply an objective comparison, one main source is used for any variable (e.g. cellular penetration) and other sources are used to recheck the data; see the sources in table 7-2 in the *Indicators* chapter. The study uses original data; the records describing the *regulatory frameworks* and the *master-data* are primary data; they are derived from basic sources: official data originated by administrations and institutions. High-ranking officials (in the ITU, CEPT, Ofcom, ANFR, FCC, NTIA, SUPTEL) and worldwide RF decision-makers and colleagues (national RF spectrum managers), who are acquainted with the author provided new primary data, orally and by electronic correspondence. Moreover, the author interviewed (during the 2006 Anatolia ITU-Plenipotentiary) two telecommunications Ministers (Brazil and South Korea) to understand their decisions on adopting the digital TV standard. Secondary data is used to compare the findings with other researchers; e.g. the work of Paik with others (2002) on 'strategies of wireless service using the license exempt RF bands'.

The main difficulty encountered in the collection of data was completing the data for all countries; many countries (generally the least developed countries, some developing countries or non-sovereign countries) do not provide information on their RF factors (e.g. TV standard and cellular penetration). Therefore, the author searched all available sources: public domain publications and regulators around the world; the data of most countries is included in Appendix B *master-data*, so the level of missing data is insignificant to the results. Some information is fluid: many countries that operated SECAM in the past are now changing to PAL standard; the first decision for analogue TV is used in the *master-data* and the statistics. Regarding new wireless technologies (such as third generation '3G' cellular and Digital TV standards), many countries remain undecided as to which standard to use; the data represents a "snapshot" as of 9 January 2008.

2.4.3 Multiple Observers

The author benefited from colleagues' assistance; international experts were asked to look at small sections of the thesis and were invited to comment on data and ideas. These 'multiple observers' provided important information, assured the accuracy of the data and the accumulation of worldwide knowledge and experience; the multiple observers serve to bridge the practitioner's and academic knowledge. Appendix A specifies the external experts.

2.5 Three Sociological Theories Explain Different Rationalities

2.5.1 Choice of Theories

To explore RF allocation and regulating uncertain risks three sociological theories are used. *Cultural Theory* is the obvious choice to explain why culture influences RF allocation and licensing; it has been widely used to analyse *societal* and *risk concerns*, with considerable success. *Bounded Rationality* is chosen as it can also analyse attitudes to risk; *Bounded Rationality* is most suitable to explain the apparent irrationalities and the exceptional findings. With respect to *Rational Field Theory*, this is an emerging approach which so far has been applied mainly in the health sector, but which has useful attributes for the purpose in question; as philosophical beliefs, desires, worldviews, ethics and values influence the regulatory policy, they are included through the *Rational Field Theory*, to make the research more meaningful. So, all three theories shed useful insights and are hence successful in that sense. This in fact fulfils the second half of the first research question and the second research question.

2.5.2 Interdisciplinary and Multi-Rationality Approach

The theories are used to explore the empirical findings through diverse cultural prisms. The different perceptual filters, the bounds of rationality and regulators' beliefs illuminate decisions in ruling, adopting wireless standards and regulating uncertain risks. Plurality of rationalities are analysed; interdisciplinary perspectives cover a wider range of considerations. Because of its centrality, risk is of interest to many disciplines: scientists, engineers, economists, social and political scientists. The allocation and licensing of RF is tackled as an inter-disciplinary research in the fields of social sciences and engineering. Three sociological theories are synthesised for the first time to analyse *societal* and *risk concerns* in allocating the society's resource RF, and licensing services of general economic interest. A multi-theoretical approach is essential in investigating this complex pattern of regulation; as a consequence, three theories explain the different aspects of the wireless rules and standards. The synthesis of the theories ties the results together and, it is hoped, generates a useful output. The analysis of multi-rationality in regulating RF and uncertain risks fulfils the third research question.

2.6 How Components of the Methodological Framework Fit Together

The dataset is large, and undergoes considerable exploration. The research includes descriptive data on *regulatory frameworks* for wireless communications and RF limits of *human hazards* and *spurious emissions*. The *case studies* cover the most influent continents and countries, and the developing world; the *master-data* correlates the significant wireless applications to geographical and cultural attributes. The thesis takes a worldwide, multi-geographical, multi-cultural and multi-disciplinary approach. The regional and administrations *case studies* are explored systematically. Their *regulatory frameworks* are analysed by presenting the main players and the overall approach; the synthesis combines tables to 'compare and contrast' regions and countries. Three sociological theories are synthesised and offer different prisms through which to explain the empirical results and the exceptional findings.

3 Theories

Since there is no best or optimal solution to RF regulation, the research is about choices and bounded decisions. The regulatory regimes in different sub-regions and countries are introduced and analysed by three theories: *Cultural Theory*, *Bounded Rationality* and *Rational Field Theory*. The thesis revolves around the application of these sociological theories of risk to the management of the RF spectrum and associated risks. It does not deny that there are other ways of looking at the issues, e.g. historical and political analysis; colonialism is considered as the central source of the currently most common languages, religions and legal origins, analysed in the thesis.

1) Based mainly on the publications of Michiel Schwarz and Michael Thompson (1990)[3], Mary Douglas and Aaron Wildavsky (1982)[4], *Cultural Theory* describes the four cultural worldviews, classifies individuals and countries into four cultural prototypes, contrasts collectivised with individualised rationalities and explores the regulation of uncertain risks.

2) Herbert Simon (1982)[5], Daniel Kahneman and Amos Tversky (1979)[6], and Vernon Smith

[3] *Divided We Stand- Redefining Politics, Technology and Social Choice*.
[4] *Risk and Culture: an Essay on the Selection of Technical and Environmental Dangers*.
[5] *Models of Bounded Rationality*.

(2002)[7] established the idea of *Bounded Rationality*, according to which, culture and geography may bound the rationality of individuals and decision makers. If we understand the rationality of the regulators, their mental horizons and what determines them, then we have the prospect of seizing new opportunities, according to this theory.

3) David Seedhouse (1997)[8] founded the *Rational Field Theory*; it explores allocation and licensing processes. The contribution of *Rational Field Theory* to the research is in indicating how values guide regulators. *Rational Field Theory* explains the 'rationale' and the philosophical values inspiring RF allocation and the regulation of uncertain risks.

The thesis analyses the rationality in regulating RF and the social response to risk; the common denominator of the three theories is the regulator's rationality. The national RF regulation and standardisation are linked to sovereignty, as countries joining regional organisations concede some of their sovereignty. The thesis compares the relationship between national and regional regulation, and contrasts the European and South American institutional types of regulator.

4 RF in General

Between 1864 and 1873 James Clerk Maxwell (1831-1894), a Scot theoretical physicist, demonstrated that four relatively simple equations could fully describe electric and magnetic fields and their interaction. He described how charges and currents produce an Electro Magnetic Radio wave. In 1887, in the research laboratory of a young German physicist, Heinrich Hertz, the first radio transmitter began working briefly over a range of just a few metres. Alexander Popov (1859-1906) demonstrated his instrument for the detection and recording of electrical oscillations on 7 May 1895. In the spring of the same year, Guglielmo Marconi (1874- 1937) took his wireless experiments outdoors and soon discovered that an intervening hill was no barrier to the reception of electromagnetic waves. Today there are more than 3 billion cellular telephones worldwide.

The Radio Frequency (RF) spectrum is a natural resource; it is commonly agreed that wireless telecommunications need regulation at national, regional and global levels. The first sentence of the International Telecommunications Union (ITU) constitution fully recognises “the sovereign right of each State to regulate its telecommunication”. The sovereign right of states to act independently within their territory is enshrined in general international law. RF is a national limited resource, much like water, land, gas and minerals. Like these, it is

[6] 'Prospect Theory: an Analysis of Decision Under Risk', *Econometrica* 47, 263-91.
[7] “Constructivist and Ecological Rationality in Economic” *Nobel Prize Lecture*.
[8] *Health promotion: Philosophy, Prejudice and Practice*.

scarce; however, the RF is renewable and not nearing exhaustion. It requires optimal utilisation; on the other hand, if we do not use the RF spectrum in real time, this is an economic waste of a national resource. The RF is an ethereal medium, carrying wireless e-Communications: a networked service of general economic interest (similar to transport, gas and electricity). RF regulation is nationally important in theoretical, policy and practical terms. Technological advances, innovation, penetration of new technologies, economic and military power is directly connected to wireless regulation. The radio frequencies serve as a lever to raise the economic and social conditions of the society.

The RF ether is not related to any cultural factor per-se: history, tradition, language, religion or legal origin. RF is perceived as a technical rather than cultural factor; as compared to currency, legislation, taxes or left-hand driving issues. In RF allocation the common denominator among countries may dominate the whole. For this reason the RF standards can be harmonised more easily (in comparison with, for example, foreign affairs), and the national RF allocation chart can be copied as is, from country to country (if located in the same ITU Region). Lessons, ideas and technologies can cross the ocean easily, as RF is identical worldwide, exists everywhere, serves all races, and deserves to be utilised rationally, for worthwhile applications- i.e. safety of life, emergency, multi-cultural broadcasting, health, education and human welfare.

Regulation and standards vary across cultural regions. By studying the RF *regulatory frameworks, societal* and *risk concerns* both theoretically and empirically, the thesis seeks to advance our understanding of the ways and factors in which culture and geography matter. This thesis concerns the diffusion of technology and regulating RF risks– in particular how standards for cellular radio and television have spread around the world, and how the discrete geopolitical power of US and EU has influenced these standards adoption.

5 RF Standards and Emission Limits

Preamble

The following citation of Malcolm Johnson[9] highlights the importance of the standards and universal thresholds: 'A common set of standards is like a universal language: it brings people, businesses, functions, economies and societies together. In a world constantly growing in complexity, common standards make things easier'. This section provides informative material on the RF standards referred to throughout the thesis. It is a comparative background section describing the RF standards and RF emission limits. This

[9] Malcolm Johnson, Ofcom UK, International Co-ordinator with lead responsibility for UK in ITU and CEPT. Malcolm has been elected on 14 Nov. 2006 as Director of the ITU-T; he appears in the experts' list Appendix A.

material is helpful in order to understand the technical differences. Colour TV standards (NTSC, PAL or SECAM) and cellular standards (GSM, CDMA, UMTS or TETRA) are the dependent columns in the *master-data* of the thesis. Standards evolve on the basis of existing technology; for example, the digital TV standard is related to the analogue colour TV standard, which in turn is built on the older black and white TV standards. Once the operators, suppliers and users have invested in one system or standard, they will be reluctant to change to another system swiftly; operators and end-users will default to purchasing from the present suppliers. Therefore, the present RF standard influences the adoption of the future standard.

The exploration of emission limits serves to compare the *societal concerns* and different levels of risk tolerability worldwide; this section explores the permitted quantified RF limits for *human hazards* and *spurious emissions*. The emission thresholds are related to the planning process and the equipment standardisation. The bounds can be divided into requirements limiting RF wanted (intentional) and unwanted (non-intentional) emissions. The wanted emission thresholds (*human hazards*) are motivated by health safety concerns and quality of service, while the unwanted emissions in the spurious domain are motivated by RF sharing considerations. In this section these two emission concerns are considered. It is a comparative study of the EMF (Electro Magnetic Fields) exposure levels from cellular (base stations and handsets) and power lines, and the regional levels of *spurious emissions* from transmitters.

RF standards rest on RF bands; the RF allocations are different in the three ITU Regions (see next chapter): Europe-Africa (Region 1), the Americas (Region 2) and Asia (Region 3). The standards and emission thresholds are compared mainly in the European and US hemispheres; Japan is repeatedly referenced, as Japan applies unique standards and emission thresholds. Sections 6.1 to 6.3 introduce the RF standards (television and cellular), 6.4 and 6.5 detail the RF limits (*human hazards* and *spurious emissions*).

5.1 Television Standards

The broadcasting service consists of sound, video and data broadcasting. Video broadcasting is a point-to-multipoint TV transmission for public reception, typically from a fixed emitter to fixed and portable receivers. The black-and-white (B&W) TV standard is characterized by a field frequency and a certain number of lines in the picture. When a country established an analogue colour standard, it was in such a way to be compatible with its existing B&W

standard[10]. The horizontal frequency (line repetition frequency) was defined by the field frequency: the early B&W scanners were all driven by electrical Alternating Current (AC) synchronous motors (50 or 60 Hz); moreover, field frequency was set in the vacuum-tube era, so it had to coincide with the mains electricity frequency to avoid picture waving. The analogue colour systems had to use the same B&W TV country standard for B&W compatibility. Consequently, even the more modern analogue colour standard remained tied to the main frequency of the AC supply 50/60 Hz; moreover some digital TV formats are also linked to AC supply frequency, as the picture may be viewed on a legacy screen, through a digital to analogue converter (set top box) or other means. The channel bandwidth of the colour TV (6 MHz in America and Japan, 7-8 MHz in Europe) must fit the B&W bandwidth. Digital television is incompatible with analogue TV in terms of how the broadcasted information is represented as a signal. However, it must have RF spectrum compatibility. An important factor in defining the digital standard is to consider the channel bandwidth of existing analogue standards (or smaller bandwidth). Countries currently using PAL or SECAM with an 8 MHz UHF bandwidth are likely to choose only a standard that can handle such channels (DVB-T), while those which use NTSC or PAL with 6 MHz bandwidth may choose any of the standards, while maintaining the bandwidth compatibility[11].

5.1.1 Analogue TV Colour Standards

The world has been divided into three major colour television systems: NTSC, SECAM and PAL; there are also sub-variants (such as NTSC-M, PAL-N and SECAM-D). The standards are not compatible: television sets, Video Cassette Recorders (VCRs), DVD players and camcorders must be multi-standard[12] in order to decode the colour signal of more than one of these, making it difficult to internationally exchange programs or transmitters. The number of lines and frame (or field) rate are correlated to the power supply, 50/60 Hz alternating current[13]. The details on the terrestrial analogue TV standards are based mainly on Recommendation ITU-R BS.707-5. The basics of the three standards are very similar. The TV signals include black and white information (having a bandwidth of about 5 MHz), a relatively narrow band of several hundred kHz wide colour signal and a sound signal. Table 5-1 compares technically the three analogue TV Standards; it illustrates that:

[10] For example: colour standard NTSC-M is backward compatible with B&W-M, and PAL-N with B&W–N.
[11] On 16 Nov. 2007 there is no digital TV equipment of the American ATSC and Japanese ISDB at 7 or 8 MHz bandwidth to operate properly in Europe, Africa and West Asia, due to the dissimilar bandwidth.
[12] This is the case in Israel (VCR, TV and camcorders are multi-standard); however, in the USA it is hard and expensive to order a multi-standard TV since it is so unpopular. Are Americans ethnocentric and not adapted to what is going on elsewhere in the world?
[13] In old analogue colour TV receivers, it was preferable to match the screen refresh rate to the power source, to avoid wave interference that would produce rolling bars going up and down on the screen.

—PAL and SECAM have a sharper picture (more lines per frame) than NTSC, 625 lines versus 525;

—The fields per second are derived from the different mains electricity (60 Hertz and 50 Hz);

—PAL and SECAM make use of similar video bandwidth;

—PAL-M and NTSC are alike.

Table 5-1 Technical comparison of the three analogue TV standards

<table>
<tr><th></th><th>Lines per frame (visible lines)</th><th>Fields per second</th><th>Line Frequency (Hz)</th><th>Video Bandwidth (MHz)</th><th>Colour subcarrier (MHz)</th><th>Subcarrier Modulation</th><th>Year implemented</th></tr>
<tr><td>NTSC</td><td>525 (480)</td><td>59.94[14]</td><td>15,734.264</td><td>4.2</td><td>3.58</td><td rowspan="2">Quadrature Amplitude (QAM)</td><td>1954</td></tr>
<tr><td>PAL</td><td rowspan="2">625 (576)</td><td rowspan="2">50</td><td rowspan="2">15,625. Only for PAL-M 15,734.264</td><td rowspan="2">5; 5.5; 6</td><td rowspan="2">4.43; PAL-M 3.58, PAL-N 3.58</td><td rowspan="2">1967</td></tr>
<tr><td>SECAM</td><td>Frequency (FM)</td></tr>
</table>

5.1.2 Terrestrial Digital TV

In the 21st century analogue e-Communications are evolving to digital. Analogue TV therefore naturally evolves to digital TV. The digital TV technologies provide new possibilities to compete with the RF spectrum scarcity and TV quality; digital TV offers the possibility of transmitting a single high definition program or about 6 programs in a single TV RF channel. The three international standards for digital TV were developed by the so-called 'triad powers': the US (ATSC), Europe (DVB-T) and Japan (ISDB-T). The Japanese, American and European governments have been actively involved in making policies intended to promote national champions and impeded foreign competitors (Dupagne and Seel 1998:294). Japan convinced Brazil to adopt ISDB-T with technological and economic (such as building a television factory in Brazil) rationales; the US convinced President Carlos Menem in 1998 to adopt ATSC (now it is reassessed in Argentina); Europe organised the Regional Radio Conference 2006 (RRC-06) also to convince all ITU Region 1 to adopt DVB-T. DMB-T/H (Digital Media TV Broadcasting-Terrestrial/Handheld) is deployed in China.

Geography influences the adoption of digital TV modulation. Single 8-VSB is the 8-level amplitude Vestigial Side Band modulation method adopted for terrestrial broadcast of the ATSC. Orthogonal Frequency-Division Multiplexing (OFDM) is used in both DVB-T and

[14] The reason for the actual frequency 59.94 Hz, not being exactly 60 Hz, is to obtain chroma and luminance frequency interleaving.

ISDB-T; it enables high-speed mobility and interference immunity in urban propagation conditions. 8-VSB has some advantages with regard to data rate, spectrum efficiency and transmitter power requirements; OFDM is stronger in combating multipath[15] and in indoor reception (FCC 1999:27). The enhanced coverage of 8-VSB is an advantage for the many rural areas of North America which have a lower population density than metropolitan ones[16]. In peripheral areas, 8-VSB performs better than other systems; in metropolitan areas OFDM is better. Therefore, the comparison of 8-VSB and OFDM ties directly to the question of how important mobility is to TV. For Europe, mobility in receiving TV seems more important than for the US; it can be explained by the higher penetration rate of cellular (see Appendix B: *master-data*): in the US 77.4 mobiles per 100 inhabitants, in France 85.08, in UK 116.39 and in Europe 94.29 (year 2006).   Table 5-2 compares the parameters of the three digital TV standards; it illustrates the likelihood DVB-T and ISDB-T.

Table 5-2 Technical parameters of the three digital TV Standards

<table>
<tr><th></th><th>Reception speed</th><th>Scanning Lines</th><th>Image size Pixels</th><th>Modulation</th></tr>
<tr><td>ATSC</td><td>Portable</td><td>1125</td><td>1920x1080</td><td>Single 8-VSB carrier codes</td></tr>
<tr><td>DVB-T</td><td rowspan="2">< 90 km/h, for 8k carriers ; <180 km/h, 2k</td><td colspan="2" rowspan="2">Flexible</td><td rowspan="2">OFDM</td></tr>
<tr><td>ISDB-T</td></tr>
</table>

5.1.3 Television Standards- Conclusion

B&W TV standardisation paved the way for analogue colour TV standards, and eventually for digital TV. The European hemisphere, characterised by 50 Hertz electrical power mains, operates PAL and SECAM colour TV and is evolving toward DVB-T; the US hemisphere, characterised by 60 Hertz electrical power supply, operates NTSC colour TV and is evolving toward ATSC. There was backward compatibility between the colour and B&W TV, but no compatibility between the digital TV and colour TV. Geography may influence directly the technical standard that is defined or adopted in a certain region: the modulation of ATSC is suited to the relatively rural North America, providing large coverage zones; whereas the OFDM scheme is suited to the more compact Europe and Japan, offering resistance to multipath from buildings in urban environments, and reception in high-speed mobiles (such as trains in Europe and Japan).

[15] Multipath: radio signals reaching the receiver by two or more paths; e.g. reflection from walls and buildings.
[16] In rural areas the main problem is coverage; due to the relative low signal to noise, 8-VSB is suitable to North America. OFDM solves the capacity problem in more condensed European and Japanese areas.

5.2 Cellular Standards

The success of cellular communications is derived from the solution to the RF spectrum scarcity in the way of frequency reuse. Mobile phones access the system by using cells in the immediate vicinity, which allows reuse of the frequencies in nearby cells, under the constraint that a minimal signal to co-channel interference is maintained. In conventional radio communications about 120 users could share one radio channel, on a time shared basis. It follows that there is not enough spectrum in the VHF/ UHF bands (appropriate for land mobile communications) to provide for 3 billion cellular users on a worldwide basis; however, by frequency reuse and the principle of cell splitting, capacity is almost unlimited[17]. In Israel, for example, with 2x10 MHz, one of the cellular operators provides 3G services (audio, video and data) to more than two million subscribers.

In 1983 the US started public mobile communications first with an analogue system (AMPS); Europe followed in 1991 with a digital system GSM; during these years, cellular services were denied from many European countries. The second US step was CDMA, which is a more advanced modulation than GSM. In the early 1990s, the analog cellular standards in Europe were fragmented; in 2005 Recommendation ITU-R M. 1073 (*Digital Cellular Land Mobile Telecommunication Systems*) lists only four cellular standards: GSM, the US TIA-136 TDMA (Time Division Multiple Access), the US TIA-95 CDMA (Code Division Multiple Access) and PDC[18] TDMA. Currently, there is still no single global standard[19] for mobile telephony, which the public can use around the world.

In the 21st century there is a cellular convergence toward two systems; in 3G mobile, two evolution paths have been recognised: the European led TDMA path, which starts with GSM evolving to UMTS (WCDMA-Wideband Code Division Multiplex Access), and the US led CDMA path, starting with TIA-95, evolving to CDMA2000. Both CDMA2000 and WCDMA have been endorsed by ITU as part of the IMT (International Mobile Telecommunications) family of 3G standards. WCDMA is the radio technology used in UMTS. As a result, the terms UMTS and WCDMA are often used interchangeably. UMTS is standardised by 3GPP[20], CDMA2000 by 3GPP2[21]. China has developed the UMTS Time Division Duplex component towards TD- SCDMA. Japan developed PDC (Pacific Digital

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[17] Limiting factors are the base station constraints - an objection of the public and economic restrictions.
[18] A Japanese digital system launched by DoCoMo in 1993.
[19] As opposed to the globally adopted Wi-Fi standard for wireless local area networks.
[20] 3rd Generation Partnership Project: a worldwide collaboration agreement that was established in Dec. 1998.
[21] GPP2 is spearheaded by ANSI (American National Standards Institute); GPP1 by a grouping of international standards bodies, operators and vendors.

cellular), which evolved to FOMA[22].

CDMA refers to digital cellular telephony systems that make use of this access scheme, such as those pioneered by Qualcomm[23]. CDMA is a method of multiple access that does not multiplex (divide up) the data stream (channel) in the time domain (as in TDMA) or in the frequency domain (as in FDMA), but instead spreads the carrier frequencies by a family of orthogonal codes, each associated with a specific user-channel. CDMA permits many users to share the same frequency band at the same time, while each uses a different (orthogonal) spreading sequence; it turns out that in a multi-cell environment more users can be served in a cell per MHz of bandwidth: larger numbers of phones can be served by smaller numbers of cell sites. Therefore, CDMA is the major access method in cellular 3G systems. Whereas the GSM is a specification of an entire network infrastructure, CDMA relates only to the air interface, i.e. the radio part of the technology. The CDMA family of the US national standards (including cdmaOne and CDMA2000) are not compatible with the WCDMA family[24]. Throughout this thesis 'CDMA' notation refers mainly to the US standards - narrow CDMA (TIA-95) and CDMA2000.

The 'CDMA' system includes highly accurate time signals, usually referenced to a GPS (Global Positioning System) receiver in the cell base station; UMTS is an asynchronous technology and hence, no need for GPS. Europeans perhaps prefer to refrain from relying on the synchronisation clock from the GPS satellites, a project controlled by the USA.

5.2.1 GSM (*Groupe Spéciale Mobile*[25])

The GSM standard is repeated frequently along the thesis. By the mid-1980s, many of the European countries developed their own cellular mobile telephony systems. This led to disagreement on what system to use across Europe. The political conflict almost stopped the project. However, the European Union intervened and all 15 countries decided to accept the CEPT (*Conférence Européenne des Administrations des Postes et des Télécommunications*) proposal, the GSM, which became the first cellular digital standard. The European GSM was initiated by France and Germany[26] in 1981 and imposed by a Council Recommendation 87/371/EEC. Today, the GSM is the most popular standard for mobile phones in the world, and is a *de-facto* global standard. GSM service is used by over 2.6 billion people across more than 221 countries (see *master-data*) (as of 18 November 2007); apparently in all countries,

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[22] FOMA (Freedom of Mobile Multimedia Access), which is a UMTS standard.
[23] A commercial company holder of several key international patents of the CDMA technology.
[24] Maybe in this way the European GSM industry wanted to keep their captive market and the Americans their spirit of competition.
[25] Became later ‘Global System for Mobile Communications’.
[26] Another example of the French/German axis leading to a greater unification of Europe.

except Japan. The ubiquity of the GSM standard makes international roaming among countries very easy, enabling subscribers to use their phones all over the world. GSM is a closed standard, allowing easy inter-operability among network operators, roaming services and the deployment of equipment from different vendors. GSM networks operate in four different frequency ranges. Nowadays, most subscriber units on the market (i.e. handset) support multiple frequencies used in different countries.

GSM is a second generation (2G) technology, precursor to 3G, with an evolution path called GPRS (General Packet Radio Service) and EDGE (Enhanced Data Rates for GSM Evolution). GPRS / EDGE, also known as 2.75G, is deployed in many places where GSM is used. Many operators install UMTS network, in order to support higher data rates. The GSM achievement is another reason of a greater cellular penetration in Europe, relative to the US (see the *Indicator* chapter). The success of GSM paves the way to the penetration of UMTS, also outside Europe.

5.2.2 Cellular Standards- Concluding Section

The cellular standards set the framework of a huge industry. The European GSM is accepted and operated in the entire world; the harmonised TETRA did not succeed as much as GSM. The US is dominant in the microprocessor and software industries (Hart 2004:226), whereas Europe is the main supplier of the cellular market, due to the top-down harmonization and the greater emphasis Europeans seemed to have been putting on personal mobile communications, with the rate of penetration exceeding that of the US.

5.3 TV and Cellular Standards- Conclusion

Backward compatibility and evolution are important: availability of the old services on the new infrastructure, with no need to change the user equipment, and as little as possible investment in the infrastructure. Therefore, existing standards typically lead to the new superior standards. The exceptional success of the European GSM opened the door to its successor UMTS; DVB-S (the satellite component of DVB) is already the leading preferred standard for satellite digital broadcasting. The successful penetration of DVB-T may be explained also by the top-down harmonisation and pulling of Africa (and part of Asia) toward Europe in RRC-06. The GSM success may promote in the future the development of other European 'cathedrals'. Globalisation has caused a convergence of the digital TV and 3G standards. Relative to Europe, the US is the pioneer of the new technologies (such as NTSC and ATSC); later, when Europe follows, it can start with a more advanced position (such as PAL/SECAM and DVB) on the evolution time axis.

GSM achievements also increased the penetration of cellular in Europe, relative to the US; Europeans have generally required that their TV be provided in mobile handsets. Increasing the mobility necessitates a more robust modulation scheme; therefore Europe and Japan have developed the digital TV modulation (OFDM) to accommodate this feature. The number of users talking, sending or receiving real time video on mobile platforms at 500 kilometres per hour (see Recommendation ITU-R M.1457 table 26) depends on geography and customs. Trains and cars move relatively slowly in the USA; trains move very quickly in France and Japan. So the modulation is different in the US and Europe/ Japan. The digital American TV ATSC was not designed for mobility; it supports only portable terminals, while DVB-T and ISDB support higher than 180 km/h mobility. Taiwan preferred the DVB-T (to ATSC) due to its mobility features.

In the 21st century, there is interactivity within TV and cellular; digital networks and terminals are enabling convergence of these two services; the convergence and integration are different in the two spheres: IMT-2000 and digital TV are converging into UMTS and DVB-T in Europe, and CDMA2000 and ATSC in North America. The cellular handset serves as a TV receiver: UMTS/ DVB-H in Europe, and CDMA2000 and Media FLO (Forward Link Only) in the US. Therefore, also the TV-cellular convergence can be viewed as separated into two hemispheres; the incompatibility in RF bands and RF bandwidth cause problems in allocating the US FLO RF channels to CDMA2000, operating outside America. In the past, compatibility was more important; for example, backward compatibility from colour to black and white TV. Digital TV and UMTS do not support analogue colour TV and GSM, respectively. This may be explained by the present low cost of electronic mass productions, enabling flexibility on the end-user side. In the consumer-aware culture of the US, the CDMA2000 is back compatible with TIA-95 CDMA.

5.4 *Human Hazards*: Risks from RF Exposure

The thesis compares the national and regional RF risk thresholds in order to evaluate the risk tolerability. It is impossible to scientifically prove absolute safety, the null hypothesis (IEEE 2006:79); it is impossible to prove the negative, the VOID (zero group). The numeric standards for non-ionising radiation exposure limits are the formal steps taken by governments to limit both the occurrence and consequences of risky exposures. Electromagnetic Fields and Magnetic Fields (hereafter EMF for both) from cellular and power lines are the *human hazards* analysed in this thesis: 1) the emissions in the RF UHF band 300- 3,000 MHz from cellular base-stations and cellular phones; 2) the Extremely Low Frequency (commonly referred as ELF) fields in 50/60 Hz, produced by high power apparatuses (generators, transformers, etc.) and utility transmission lines (power-lines). There are countless studies on EMF risks; the thesis is mainly comparative and therefore focuses on the diversity in thresholds, published by the leading standard and health institutions, without treatment of the hazards themselves.

Radiological electromagnetic standards ‘race to the bottom’ in reducing thresholds: in 1995, CENELEC (the European Committee for Electrotechnical Standardisation) established the European power density level to be 9 W/m^2, and since June 2000 the European Commission adopted the ICNIRP (International Commission on Non-Ionizing Radiation Protection) levels, 4.5 W/m^2 (at 900 MHz). The UK *Case Study* specifies that the UK National Radiological Protection Board[27] (NRPB 1993 volumes 4 and 5) limited the power-density level of *human hazards* in the GSM900 band 8.2 (!) higher than the ICNIRP and European threshold; adopting the 'NRPB 2004: Recommendation 131', the emissions from cellular base stations meet now the *ICNIRP* guidelines for public exposure. The same for health risks from powerlines (50 Hz), the NRPB 1993 and current WHO website (30/12/07) indicate the magnetic field strength's value as 16,000 (!) higher than the ICNIRP threshold; the recent threshold 'NRPB 2004: Recommendation 102' follows the ICNIRP level. Twenty years ago, emissions from terminals of less than 7 Watts were not controlled; contrarily, at present, a CDMA cellular handset transmitting at a maximum of 200 mW, undergoes regulatory testing; in Singapore, for example, Wi-Fi must comply with Specific Absorption Rate (SAR) requirements, even for emission levels as low as 100 mW emissions. More *societal concerns*, more awareness and less tolerability to risk may explain this reduction; the lower limits are also a result of media campaigns and some regulatory rivalry.

Generally there are two types of potentially adverse effects: thermal and non-thermal. Thermal effects are caused by a malfunction of the body’s thermo-regulation system when it becomes unable to regulate the heat load to the body’s core temperature (about 36.5°C). Non -thermal effects are produced by a direct interaction mechanism between the EMF and biological tissue or system, at power densities that do not necessarily increase tissue temperature. The standards and exposure guidelines are based on thermal effects, as the potential adverse impact of the latter has never been established and remains controversial.

[27] NRPB was incorporated in the Health Protection Agency (HPA) on 1 Apr. 05; now it is HPA-RPD (Radiation Protection Division).

5.4.1 RF Exposure Units and Standards

Table 5-3 lists the reference units of the physical quantities used in this thesis.

Table 5-3 Physical quantities and units

Quantity	Symbol	Unit	Symbol
Frequency	f	Hertz	Hz
Electric field strength	E	Volt per metre	V/m
Magnetic field strength	H	Ampere per metre	A/m
Magnetic flux density[28]	B	Tesla	T
		Gauss	G
Power	P	Watts	W
Specific Absorption Rate	SAR	Watt per kilogram or milliWatt per gram	W/kg or mW/g
Power density or power flux density	S	Watt per square metre	W/m^2
		mWatt per square cm	mW/cm^2

Various institutions define the allowed limits permitted in specific regions: ICNIRP (1998, *Guidelines*); NRPB (1993, *Statement*); FCC- Federal Communications Commission (1997, *Bulletin 65*), developed by IEEE (Institute of Electrical and Electronic Engineers) 1991 C95.1 and adopted by ANSI (American National Standards Institute) (1992, ANSI/IEEE C95.1); IEEE 2006 standard (C95.1-2005), not adopted by FCC[29]. ICNIRP (1998 p. 509 table 4 and p. 511 table 7) defines the exposure thresholds of the World Health Organisation (WHO) for EMF. The European Council EC 1999/519 (Annex III, tables 1 and 2) adopted its values. The following tables refer to the exposure limits for general public/ uncontrolled/ unperturbed environment (unlike the controlled/ occupational), for the cellular (UHF bands) and power lines (50/60 Hz) hazards, where 'f' represents frequency in MHz, unless otherwise stated. The IEEE/ANSI exposures refer only to the cellular exposure, not to the ELF.

A distinction is made between the exposure levels from cellular base stations and handsets. The hazards from a base station's radiation refer to the field intensity and power density generated, whereas the hazards from handsets are considered by the SAR value. The reason for the two different approaches: the far-field standard (easily computable and measured) is used for the base station case, whereas the near-field standard (SAR and phantom-based measurements) is applied for the handset case. The standards and guidelines give the 'baseline limits' for power density and SAR.

[28] Magnetic flux density is commonly measured in units of microtesla (μT) or milligauss (mG); 1 μT = 10 mG.
[29] FCC 2006 Code of Federal Regulations CFR 47§1.1310, and a message from the FCC Physical Scientist to the author on 28 Nov. 07: "the FCC has no specific plans at this time to update its exposure limits based on IEEE C95.1-2005 or ICNIRP".

5.4.2 Exposure Levels: Cellular Base-Stations and Utility Power Lines

The limits of ICNIRP (1998:511, table 7) and the European Community (EC 1999/519: Annex III, table 2) are identical. The ICNIRP levels have been endorsed by the Commission's Scientific Steering Committee. Table 5-4 specifies these exposure limits from cellular base stations and power lines.

Table 5-4 ICNIRP and EC reference levels for exposure

Frequency range	Electric field strength (V/m)	Magnetic field strength (A/m)	Equivalent plane wave power density S_{eq}(W/m^2)	Magnetic Flux Density (µT), B
25-800 Hz	250/f	4/f	-	5,000/f
400-2000 MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	f/200	$0.0046 f^{½}$
2-300 GHz	61	0.16	10	0.2

Regarding ELF, the ICNIRP Guidelines for magnetic flux density at 50/60 Hz is 5,000/f; see the last column in Table 5-4. The same formula is adopted in Europe and North America; therefore, it is 100 µT for 50 Hz Europe, and 83,3 µT for 60 Hz North America. Table 5-5 specifies the US thresholds for cellular base stations.

Table 5-5 FCC exposure limits (FCC 2001:67)

Frequency Range MHz	Electric Field (E) (V/m)	Magnetic Field H (A/m)	Power Density (S) (mW/cm^2)
30-300	27.5	0.073	0.2
300-1500	--	--	f/1500
1500-100,000	--	--	1

The IEEE maximum permissible exposure was updated in 2005 and is shown in Table 5-6.

Table 5-6 The new IEEE permissible exposure (IEEE Std C95.1-2005:25, table 9)

Frequency Range MHz	Electric Field (E) (V/m)	Magnetic Field H (A/m)	RMS power density (S) (W/m^2)
100-400	27.5	0.073	2
400-2000	--	--	f/200
2000-5000	--	--	10

The levels of IEEE C95.1-1991 and C95.1-2005 for exposure at 100-400 MHz did not change (0.2 mW/cm^2= 2W/m^2). The IEEE C95.1-2005 level for 400-2000 MHz (typical cellular RF bands) is now 4/3 more stringent (new f/200 W/m^2) relative to IEEE 1991 (f/1500 mW/cm^2 = f/150 W/m^2); the updated value is identical (not to FCC nor ANSI levels) to the ICNIRP level (f/200 W/m^2); the units now are also the same. Table 5-7, based on 2005 Recommendation ITU-R BS.1698:67 (table 9), compares the power density levels from the three renowned institutions (ICNIRP, NRPB and ANSI), before the NRPB 2004[30] (and Stewart Report 2001, influenced by media campaigns against cellular towers) and C95.1-2005 changes; the same values appear also in the 2004 Report ITU-R BS. 2037:66.

[30] In May 04 NRPB, the official radiation UK regulator (at that time), recommended adoption of ICNIRP level.

Table 5-7 Derived levels, power density (W/m²): WHO (International), UK, USA

Frequency range	ICNIRP	NRPB[31] (UK)	ANSI (USA)
	General Public	Adults and Children	General Public
400 - 1,550 MHz	f /200	$41 \times 10^{-6} f^2$	f /150
1,550 - 2,000 MHz	f /200	100	f /150[32]

This table depicts that the levels in power exposure limits of the US are 4/3 (=200/150) higher than ICNIRP and Europe.

5.4.3 Exposures: Cellular Handsets

Specific energy Absorption Rate (SAR) is the time rate of energy absorption per gram of tissue from electromagnetic radiation; it is expressed in watts per kilogram (W/kg). Table 5-8 compares the rate absorption in ICNIRP, EC and FCC[33].

Table 5-8 Maximal power from handsets: Specific Absorption Rate, SAR (W/kg)

ICNIRP	European Community	FCC- USA
10 MHz–10 GHz; Localised SAR (Head and Trunk)		Portable Devices; General Population/ Uncontrolled
2.0; averaged over 10 g tissue		1.6; averaged over 1g tissue

In contrast to the thresholds of power density from cellular base stations, it is important to observe that the US is more risk averse than Europe in the allowed SAR from the cellular terminal. The ICNIRP threshold (adopted by EC) is 2.0 W/kg, while the US limits are 1.6 watts/kg[34] for the partial body. The IEEE (2006:79) has changed the peak spatial average SAR values from 1.6 W/kg for exposure of the public environment to 2 W/kg; moreover, the SAR is to be averaged over 10g tissue as in the ICNIRP and not for 1g as before. These changes were based on the scientific considerations and were also influenced by the desire to harmonize the basic restrictions with ICNIRP, where scientifically justified.

5.4.4 RF *Human Hazards*- Conclusion

The RF exposure limits are important RF factors; the threshold variations between countries (and within the same country) reflect the *societal* and *risk concerns*, social amplification and the national tolerability to risk. The value of exposure levels is reducing with time. As there is a need to manufacture and to circulate the same cellular handsets all over the world,

[31] Those are the values appearing in the WHO website http://www.who.int/docstore/peh-emf/EMFStandards/who-0102/Europe/United_Kingdom_files/table_uk.htm on 23/11/07.
[32] The value at http://www.who.int/docstore/peh-emf/EMFStandards/who-0102/North_America/USA_files/table_us.htm 23/11/07 is 10 W/m^2; for f=1,500 MHz; 1500/150=10.
[33] ICNIRP1998:509 table 4; EC 1999/519, Annex III, Table 1; FCC 1997:75 (and FCC 2006 CFR 47 § 2.1093).
[34] Even the averaging is more stringent in the US, as the limit is averaged over one gram (FCC 2001:75), and not 10 grams as in ICNIRP 1998. Following changes in the IEEE C95.1-2005 standard, the US ANSI may adopt in the future the less stringent European level for SAR and averaging.

globalisation causes that the allowed SARs for handsets become identical in Europe and North America.

5.5 *Spurious Emissions*

Spurious emissions are unwanted RF transmissions on a frequency, and the level of which may be reduced without affecting the corresponding emission of information. The *spurious emissions* are elementary in regulating RF systems, as their levels affect the appropriate introduction of any new system; the adjacent licensed receivers may be interfered. Therefore, *spurious emissions* need the most attention from the regulator; lower unwanted emissions reduce the uncertain risk: the RF interference. The thesis compares the regional and national limits of *spurious emissions* domain. The ITU Radio Regulations (RR Appendix 3; a treaty level text) specify the attenuation values used to calculate maximum permitted *spurious emissions* levels. The different *spurious emissions* are detailed in ITU-R Recommendation SM.329-10 *Unwanted Emissions in the Spurious Domain*; the Recommendation is widely used in Europe (e.g. ETS 300 328 November 1996, CEPT/ ERC/ Recommendations 74-01 and 02-05) as well as by the USA type approvals of the FCC, Japan's (e.g. ARIB TR-T12-34.926), and various national regulators and international standardisers (such as 3GPP TR 34.926). A significant difference among regions and states is the allowance of RF *spurious emissions*. Category B, C and D are examples of more stringent spurious domain emission than Category A limits. Table 5-9 defines the four categories of spurious domain emission.

Table 5-9 Categories of *spurious emissions* limits

Category A	The attenuation values used to calculate maximum permitted spurious domain emission power levels. **RR Appendix 3** is derived from Category A limits.
Category B	Limits are defined and adopted in **Europe** (all Europe not only EU) and used by some other countries.
Category C	Limits are defined and adopted in the **US and Canada** and used by some other countries.
Category D	Limits are defined and adopted in **Japan** and used by some other countries.

5.5.1 Comparative Analysis

Table 5-10 indicates the different limits of RF *spurious emissions* adopted[35].

Table 5-10 Comparative *spurious emissions* limits

<table>
<tr><th>Type of equipment</th><th>Category A: All Countries</th><th>Category B: Europe</th><th>Category C: USA, Canada</th><th>Category D: Japan</th></tr>
<tr><td></td><td colspan="4">Attenuation (dB) below the power (W)</td></tr>
<tr><td>Land mobile service</td><td rowspan="2">All services except those services quoted:
43 +10 log P, or 70 dBc, whichever is less stringent</td><td>mobiles and base stations:
–36dBm for 9kHz≤ f< 1 GHz
–30dBm for1GHz ≤ f<300GHz</td><td>150-174 MHz and 421-512 MHz whichever is less stringent 50+10 log P or 70 dBc for 12.5 kHz channels</td><td>Analogue systems for portable/auto-mobile telephones
60 dBc
for P < 50 W</td></tr>
<tr><td>Fixed service</td><td>–50[36] dBm for 30 MHz ≤ f < 21.2 GHz –30 dBm for 21.2GHz ≤ f <300 GHz</td><td>As in Category A</td><td>30MHz < f0 ≤ 335.4 MHz; 60 dBc for P < 50 W</td></tr>
<tr><td>Broadcasting at HF</td><td colspan="2">50 dBc and the absolute mean power level of 50 mW should not be exceeded</td><td>80 dBc</td><td rowspan="2">Like Category A, for all Broadcasting: HF and FM</td></tr>
<tr><td>Broadcasting at FM</td><td>46+10 log P, or 70 dBc, whichever is less stringent; the absolute mean power level of 1 mW should not be exceeded</td><td>FM broadcasting, 87.5 ≤ f ≤ 137 MHz:
–36 dBm for P < 9 dBW;
75 dBc for 9 ≤ P < 29 dBW;
–16 dBm for 29 ≤ P < 39 dBW;
85 dBc for 39 ≤ P < 50 dBW;
–5 dBm for 50 dBW ≤ P</td><td>43 + 10 log P or 80 dBc, whichever is less stringent</td></tr>
</table>

Category A (all countries) and B (Europe) include a thorough regulation on the *spurious emissions* of low power device radio equipment in Category A, and Short Range Devices in Category B. North America and Japan, as a policy, refrain from regulating these licence-

[35] Table 5-10 and Table 5-11 are original; the values are extracted from ITU-R SM.329-10. P is mean power (Watts) at the antenna transmission line. Decibel (dB) is a standard unit for expressing the ratio between two parameters using logarithms to the base 10; dBc is decibels relative to the un-modulated carrier power of the emission; dBm is the power in decibels relative to 1 mWatt, and dBW relative to 1 Watt. Lower power levels (dBm or dBW) indicate more restrictive thresholds.

[36] Fixed Service- Terminal stations (remote stations with subscriber equipment interfaces) are more relaxed: –40 dBm.

exempt devices; Europe **does** control them. However, the US and Canada are the only countries to apply limits in spurious domain emissions in the 1,559-1,605 MHz band to protect their strategic GPS transmission. Table 5-11 compares the limits for typical systems. The power and RF values were chosen in order to compare the limits in the different regions.

Table 5-11 Comparative *spurious emissions* values (dBm) for various systems

Type of equipment	Category A: All Countries	Category B: Europe	Category C: USA, Canada	Category D: Japan
Portable, 465 MHz, 1 W, 12.5 kHz channels	-13	-36	-20	-30
Fixed Service[37], 325 MHz, 10 W	-13	-50	-13	-20
HF Broadcasting, 100 kW	17	17	0	17
FM Broadcast, 100 MHz, 10 kW	0	-15	-10	0

Except for the HF broadcasting examples, with up to a 17 dB difference (a ratio of 50 in the allowed spurious power levels), in all the other cases Europe is more stringent than the US and Canada. For the fixed service, a striking discrepancy is indicated, of up to 37 dB, i.e. the US allows spurious levels up to 5,000 times (!) higher in power than in Europe. Japan is the most tolerant in FM broadcast: 10 dB (10 times) more tolerant than the US and Canada, and 15 dB (30 times) more than Europe.

5.5.2 *Spurious Emissions* - Conclusion

There is significant diversity among the different categories. Each grouping represents a compromise between lower *spurious emissions* and the cost of equipment. Europe is the most stringent in its limits and protection of the natural RF resource. North America and Japan are more sensitive to the market needs. Europe also regulates the *spurious emissions* of unlicensed Short Range Devices, whereas North America and Japan do not. However, the US is very keen to protect its exclusive GPS.

[37] According to CEPT/ERC/74-01 table 1.1, the same limits apply also for fixed receivers.

5.6 RF Standards and Thresholds - Conclusion

This section compares the RF standards in RF allocation and licensing around the world. The thesis utilises primarily the television and cellular systems in order to reveal the influence of geopolitical affiliation, geography and culture on adoption of standards. The permitted levels of EMF and *spurious emissions* disclose the *societal concerns* and the risk tolerability. This section shows a regulatory convergence toward two hemispheres: the European – regulated by CEPT and EU, versus the American standards, led by the US (and Canada). Table 5-12 compares Europe versus North America. The table highlights the divergence between the two hemispheres, which the thesis explores.

Table 5-12 Standards and thresholds: Europe versus North America

<table>
<tr><th>Standard</th><th colspan="3">TV</th><th rowspan="2">Cellular standardised</th><th rowspan="2">Main Power and TV frames/s</th><th rowspan="2">Spurious Emissions</th><th colspan="2">Human Hazards</th></tr>
<tr><th></th><th>Analog</th><th>Digital</th><th>Bandwidth</th><th>Base Stations</th><th>Handsets</th></tr>
<tr><td>Europe</td><td>PAL-SECAM</td><td>DVB-T</td><td>7-8 MHz</td><td>UMTS/ TETRA</td><td>50 Hz</td><td colspan="2">Stringent</td><td>Flexible</td></tr>
<tr><td>North America</td><td>NTSC</td><td>ATSC</td><td>6 MHz</td><td>CDMA2000</td><td>60 Hz</td><td colspan="2">Flexible</td><td>Stringent</td></tr>
</table>

Europe and North America apply different levels of RF *human hazards* and *spurious emissions*. A “central planning” Europe is more inclined to adopt a precautionary principle in *human hazards* and to protect its congested RF spectrum by enforcing stringent *spurious emissions*. North America prefers a more *laissez-faire* policy, in order to lower prices of cellular equipment.

The RF levels of *human hazards* are becoming more stringent worldwide; due to globalisation, the thresholds may converge to the universal levels of ICNIRP. Worldwide standards and universal thresholds (*human hazards* and *spurious emissions*) will avoid a Babylon tower of standards that confuse suppliers, operators and users. However, two leading hemispheres (European and North American), with distinct standards, do contribute to competition and promote research and development. Japan is the most innovative in implementing new technologies in TV and cellular: first to develop and deploy High Definition TV, a 3rd generation cellular infrastructure, and pioneered in various digital technologies. However, Japan did not succeed in exporting its domestic standards and consequently, its supply of equipment.

Careful analysis of the results appears in the *Case Studies*, *Indicators*, *Discussion* and *Conclusion* chapters to explore and explain the differences by *societal* and *risk concerns*.

Chapter 1- *Literature Review*

Contents

Figures

1 *The Regulatory Framework*

1.1 Regulation in General

'Regulation is the process by which governments seek to influence markets in order to achieve social and economic objectives' (Ofcom 2007:19). National regulation is the bulwark of sovereignty (Hills 2002:292); countries joining regional organisations concede and lose some of their sovereignty; their regulation is the barrier and the bound of their nationality. There are some that argue that culture defines regulation and hence is all-important to understanding the regulatory process (Hall, Scott and Hood 2000:5 and Meidinger 1987:355-86). Hugh Heclo and Aaron Wildavsky (1974), in a study of the British civil service, observed that if anything regulated the upper reaches of that bureaucracy, it was a shared ethos; distinctive values and beliefs regulate the system; culture defines the social and cognitive boundaries. Mary Douglas (1985:3, quoted in Hood *et al.* 1999:13) has written of culture as 'a general regulatory mechanism for human behaviour'. Culture biases the regulatory arrangement; therefore this research analyses cultural context and aspects. Regulation is mainly prepared by Member States for Member States, whereas standards are prepared by industry for industry. In fact, standards have largely been the domain of 'industry and trade, and with (only) a modest input from consumer representatives' (Ball 2001a.:3 quotes Rogmans 1997:215-21).

The fundamentals are the same if we explore health, environmental or RF regulations. These utilities are an essential component of human happiness and safety; thus, the normative force of risk characterisation appears via regulations, to reduce exposure to risk agents (adapted from Jaeger CC., Renn O., Rosa EA. and Webler T. 2001:91). Every technological advance carries some risks of adverse side effects (Slovic 2000:81). The risks are co-optation and clever dodging of the regulatory intent (Brennan and Berwick 1996:22).

Regulation has been analysed from many other disciplinary perspectives, including anthropology, social administration, social psychology and geography (Baldwin, Scott and Hood 1998:8, referring to Noll 1985). Graham and Wiener (1995:Foreword p. x) indicate the importance of law in risk regulation. Laws bind regulations; regulators are not free to act, except within the realm of their knowledge and beliefs; the legislation has an essential role in *regulatory framework* and licensing. The subjectivity[1] within which we interpret the world exists also in the different views of the law (Altman 2001:124). In RF allocations we also encounter different worldviews: the letter of the law versus the spirit of the law. Altman (2001:111-6) argues about law with respect to the idea of common law and the public-

[1] The roots of this lie in Ancient Greece: the quotations of Anaxagoras and Protagoras.

private distinction.

Regulatory intervention could be questioned (Larouche 2000:388), as any intervention obligates regulator's resources and actions by the public or the industry. Under EC (European Community) law a ‘general public interest’, referred to as 'essential requirements', justifies certain restrictions on the free provision of services or the free establishment of telecommunications. The European Council Directive 1990/387 (quoted in Larouche 2000: 360) lists these as: security of network operations, maintenance of network integrity, interoperability of services, protection of data as appropriate and the effective use of frequency spectrum. Access to RF spectrum justifies individual licensing regimes, pursuant to EC Directive 1997/13/EC (Section III Individual Licences Article 7 Scope). Rights of way and physical space are compared to RF spectrum; rights of way are as important for wire-based networks as frequency bands are for wireless ones (Larouche 2000:362); the application of competition law is not sufficient; under complete liberalisation the state encounters problems in providing telecommunications to every citizen (Larouche 2000:367).

1.2 Regulating Scarce Resources and Uncertain Risks

Inquiry tends to focus on risk assessment, but the real unknowns are in the realm of decision-making[2]. The table from Morgan and Henrion (1990:26, table 3.2) depicts the decision criteria and provide a tool to examine and evaluate decision-making, in regulating scarce resources and uncertain risks. Decision criteria are based on utility, rights and technology. RF spectrum is a common good, in particular the licensed exempt bands. Governments alleviate scarcity through regulation (Brennan and Berwick 1996:16). The RF spectrum management seems to be a ‘natural monopoly’[3], as there is generally one regulator for any RF band. Concepts, developed in the resource field, address loss through resource degradation, as well as gain through proper management (Rayner and Malone 1998:270). Air, water, gas, electricity and roads are a relevant comparison to the scarce resource of RF spectrum. Services of general economic interest are networked; they should ensure universal[4] access. They are basics for the welfare of citizens; so even if these services (transportation, electric energy, water, gas, postal service, fixed and wireless telephony) are privatised, they need rules, to guarantee a nominal service to any citizen.

‘Decisions taken on allocation of frequencies to private firms very much shape the whole telecommunication sector’ (Larouche 2000:361). It is useful for the research to look at the

[2] Paraphrasing Paul Slovic speaking at the 1998 annual conference of the European Society for Risk Analysis; see also Ball and Boehmer-Christiansen 2002, concluding discussion.

[3] Compare to the concept of Jeremy Bentham and John Stuart Mill, in Vernon Smith (2002:504).

[4] Directive 98/10/EC *Universal Service for Telecommunications*: "any one should get access to telecommunications".

ways in which other scarce resources and uncertain risks are regulated, to give ideas on possible regulatory methods, and to draw some initial conclusions on which geographical areas/cultures are more likely to regulate and why. Climatic improvement like RF allocation[5] meets the two formal criteria for a public good: non-rivalry and non-excludability (Rayner and Malone 1998:273). The research studies the regulation of RF *human hazards*; in this regard Europe implements the ‘precautionary principle’. The ‘precautionary principle’ or ‘*Vorsorgeprinzip*’ was adopted by former West Germany in 1976 in the environmental area, and since has been extended more generally into many areas of EU regulatory decision-making; for example, growth hormones in meat (Baldwin, Scott and Hood 1998:17, quoting the Royal Society 1992:155). Europe is applying the same 'precautionary principle' to restrict the *spurious emissions* and *human hazards* thresholds. The regulation of RF spectrum is more evident than, for instance, climatic improvements, as people may exert full control on man-made RF emissions.

1.3 Type I and Type II Errors in Regulation

Jeremy Bentham considered protection from harm, as more basic (and an aim of regulation) than provision of enjoyments: "the care of providing for his enjoyments ought to be left almost entirely to each individual: the principal function of government being to protect him from suffering" (Bentham 1789/1948:301, quoted in Shrader-Frechette 1991:285). An assessor's *prima facie* (at first sight) duty is to minimise the chance that an unsafe technology is implemented; in order to minimise public risk. This is a value judgement: is it more important to protect the public from harm (hazards from risky technologies, such as cellular towers), than to provide welfare (benefits from new technologies, such as third generation services and better cellular coverage)? The perception and response type I and type II errors in regulation reveal the rationality of the regulator. The research analyses the national thresholds pertaining to RF *human hazards* and *spurious emissions*.

A Type I error indicates the rejection of a null hypothesis (meaning no harmful effect, in this case) that turns out to be true, whereas a Type II error shows acceptance of a null hypothesis that turns out to be false (Baldwin, Scott and Hood 1998:15-6 and Hood *et al.* 2001:181). ‘*Errare Humanum Est*’[6]: on the side of which of these outcomes Type I or Type II - should regulation prefer to err? The debate is between safety (the risk averse regulator seeks the safest option and prefers a Type I error) and development (innovation and risk seeking, Type II). The Type I error imposes regulatory restrictions on factors that turn out to be harmless.

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[5] Therefore the *societal concerns* of the climatic change are significant to this thesis.
[6] To err is human; Lucius Annaeus Seneca, the Younger 4BC-AD65.

An example of this from the thesis would be the excessive restrictions imposed on cellular base stations (and transmitter *spurious emissions*), despite the fact that these hazards (when following the international rules) are not scientifically proven. This error encumbers telecom industry and service providers, as they are asked to implement bureaucratic restrictions that may not be necessary. A Type II error depicts the dangers of failing to regulate substances that turn out to be harmful. For example, as far as *human hazards* from cellular devices (and *spurious emissions*) are concerned, this error exposes more than 3 billion cellular users to RF hazards (and interference for receivers); the delay in identifying asbestos and smoking hazards is a Type II error. Regulators usually are conservative and are aware that the public may forgive Type I errors (even though they may be costly to the taxpayer), but would not let Type II errors pass unnoticed.

1.4 Hood's Typologies of Organisations and Attitudes to Risk

1.4.1 Typologies of Organisations

For environmental and risk regulation, cultural analysis is deservedly coming to occupy a central place in elucidating who fears what and why (Baldwin, Scott and Hood 1998:38l, referring to Meidinger 1987:355-86). Baldwin, Scott and Hood (1998:38-9) propose to generalise the analysis, as was carried out by Schwarz and Thompson (1990); the two opposing rationalities are analysed: the hierarchist logic of a major multinational corporation, and the egalitarian logic of hardcore environmental campaigners; this conflict is an example of exploration that is applicable to other areas of regulation which occupy a cultural crossroad.

A way of interpreting a regulatory style is to see it as a case of regulation in government going up-grid and up-group relative to its charges (Hood *et al.* 1999:197). The terms *grid* and *group* come from *Cultural Theory* (Douglas and Wildavsky 1982) and refer, respectively, to the degree to which one social group stands out from another. Hood (Hood *et al* 1999:14, based on Hood 1998 and Hood 1996) summarises the formal public management oversight and control, creating a typology of four (derived from *Cultural Theory*) institutional types of regulator: four social bases of control. The different modes of governance are alternatives to comptrol (termed 'comptrol' in Hood 1986), in one sense, but in practice are often linked to formal oversight (Hood *et al.* 1999:13-4). There is one 'oversight' mode of governance and three other 'inspector free' types of control over public management:

– The *egalitarian* is known as 'oversight' (or 'comptrol' or 'bureaucracy') applying 'command and control' techniques;

— The *Fatalist*: the 'contrived randomness' - control of unpredictable processes;

— The *Individualist* is represented by 'competition' - control through rivalry and choice; 'inspector-free' control over bureaucracy: a system held within limits without overt controllers in the form of official overseers - the bureaucratic equivalents of Adam Smith's 'hidden hand';

— The *Hierarchist* is represented by 'mutuality' - control through group processes.

Hood's separation into two (in addition to four) perceptual filters: 'centralised' ('oversight and mutuality' - the *hierarchist* and *egalitarian* types) and 'market-based' ('competition and randomness' - the *individualist* and *fatalist* types) is helpful to this research.

1.4.2 Regulation Regimes and Attitudes to Risk

Chris Hood proposed using risk tolerability as a mode of regulation (alongside hierarchy, markets and networks). There are different risk regulation regimes rated by their regulatory control dimensions (Hood *et al*. 1999:49). The "regulatory regime" is defined as the 'complex of institutional geography, rules, practice, and animating ideas that are associated with the regulation of a particular risk or hazard' (Hood *et al*. 2001:186). It is an elusive concept: 'there is … no single correct way of conceiving risk regulation regimes; no one has ever seen a risk regulation regime.' (id.); 'a cultural theory perspective leads us to see in risk regulation … four polar approaches that could be expected to manifest themselves in different regimes.' (id.).

1.4.3 Chris Hood: Summary

The works of Chris Hood are significant to the thesis; the ideas are applied to explore regulatory agencies. Hood's typologies of organisations and his work on attitudes to risk provide an introductive theoretical background. The classification to four cultural prototypes and the additional clustering to collectivised versus individualised rationalities is productive, as the author also compares and contrasts the cultural and geographical hemispheres by collectivised versus individualised.

1.5 Collectivised versus Individualised Rationalities

1.5.1 Top-down and Bottom-up Rationalities

What are the priorities and preferences of the public interest: the collectivised rationality or the individualised approach? What is the public interest in RF allocation and licensing? The former chairman of the FCC (the US Federal Communications Commission), Powell, provides one possible answer: 'Full and complete consumer choice of wireless devices and services is the very meaning of the public interest' (Powell 2002:6). Two extreme worldviews illustrate opposite rationalities: a single top-down benevolent dictator (the

Leviathan of Thomas Hobbes 1651), and an anonymous bottom-up market populated by many well-behaved individuals (the 'Invisible hand' of Adam Smith 1776/1976:477). The conflict of the collective Utilitarianism and the individual rights is discussed in many texts; e.g. Seedhouse (1997: figure 9). Most of the developing countries are 'collectivist', whereas the developed West is 'individualist' (Greif 1994:913). Individualism is the cosmological belief to be found only in the West; it was a 'package' of the cosmological beliefs of individualism, political decentralization, and the application of the 'inquisitive Greek spirit' that led to the success of the West (Mantzavinos 2001:251, referring to the 'cosmological beliefs' of Lal 1998).

Harmonised top-down regulation provides worldwide interoperability (and a certain degree of monopoly); moreover, collectivised societies and organized groups are more likely to exercise power from above (Licht, Goldschmidt and Schwartz 2004:8). The countries with a heritage of British rule have lower cultural harmony than countries without such a heritage (Licht *et al.* 2004:22); 'cultural value emphases may preserve and perpetuate the imprint of ancient intellectual legacies and historical initial conditions' (Licht *et al.* 2004:31). Bottom-up standards offer pluralism, competition and a spread of risks; competition is desirable to the consumer since prices are thus lowered and quality of services is improved.

1.5.2 Religious and Economic Freedom

Religious freedom is linked to economic freedom (Anderson 1988:1086). Since Max Weber's (1904-5) famous essay on the effect of the Protestant ethic on national development, social scientists have linked Protestantism with economic growth and prosperity. The German sociologist claims that Protestantism may promote capitalism: Protestants seek **change** (Weber 1904-5/1947:38), movement, hard work and progress (id.:45). La Porta *et al*. 1999 distinguishes Protestantism as less hierarchical than other religions; thus, it may be implied that Protestantism might promote good governance. Like others, Robin Grier (1997:53) indicates the positive correlation between the growth rate of Protestantism and economic growth; Grier (1997:49) refers to the reverse causality: Capitalism existed before the Reformation, and may have led to Protestantism. Protestants divide between the human and the divine; this division might explain why in Protestant countries (Catholic France is an exception, see Chapter 3 *Case Studies*) there is more pluralism[7] and an apparent separation between Religion and State. Fanfani 1936 (quoted by Grier 1997:57) states that all religions have a negative effect on development; the separation of church and state, that occurs in many Protestant countries, is the real driving force behind

[7] Chojnowski (2003) reviewing Fanfani (1936), http://www.angelusonline.org/print.php?sid=443 30/12/07.

economic growth. The Islamic world view is different from that of other Monotheistic religions. The Islamic concept of *ummah*[8] is the universal community (Mowlana 1997:202,230). Sovereignty belongs to Allah and not to the state or people; the Islamic state is God-fearing rather than a political state (Mowlana 1996:67).

Culture is not the only factor: societies with the same cultural heritage but different formal (and informal) rules will have different patterns of economic growth (Mantzavinos 2001:249). The legal origin is linked to the religion and worldview: 'Catholicism might shape judicial formalism' (Djankov *et al.* 2003:31); 'the Roman law has always retained its supremacy in the Catholic countries of Southern Europe' (Weber 1904-5/1947:77). For the thesis, it is an important distinction between North and South Europe and America, as North Europe and North America are mostly Protestant, and the South is Catholic.

1.5.3 Opposing Interpretations on how to Serve Consumers and Business

The regulation policy and *regulatory framework* are derived from the answer to the basic questions: what is the ultimate benefit to the citizen, and how to promote the interests of citizens and business? Different interpretations of democracy exist. Thucydide expresses the European view[9] of democracy: ‘Our Constitution...is called a democracy because power is in the hands not of a minority but of the greatest number’; the *collective* (of majority) is the sovereign. The definition of the American democracy, ownership and sovereignty is best stated in Abraham Lincoln ‘Gettysburg Address’ (19 November 1863): ‘Government of the people, by the people, for the people’[10]. It states that ‘the people are the sovereign and the ultimate source of political legitimacy’ (Altman 2001:91 quoting Ackerman 1991); the power is handed to the *individum*.

2 *Societal* and *Risk Concerns*

2.1 Definitions

Societal concerns are defined in a landmark publication[11] as: 'the risks or threats from hazards which impact on society'. 'Societal concern due to the occurrence of multiple fatalities in a single event is known as societal risk. Societal risk is therefore a subset of societal concerns' (id.). 'Risk concerns are driven by particular actors informed by particular sensibilities, in historical and political contexts' (Burgess 2006:330).

Risk is the likelihood or probability that a person will be harmed by a particular hazard; hazard is an intrinsic property or condition that has the potential to cause an adverse health

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[8] *Ummah* is originated from *um* meaning mother in Arabic; *ima* in Hebrew is mother; from the same root.

[9] ThucydideII,37; see under the title in the preamble of the *Draft Treaty establishing a Constitution for Europe*.

[10] http://showcase.netins.net/web/creative/lincoln/speeches/gettysburg.htm 27/2/08.

[11] Health and Safety Executive (2001:12), quoted by Ball and Boehmer-Christiansen (2007:557).

effect (IEEE 2006:7,9). We may define risk as a compound measure of the probability and magnitude of adverse effect; regarding fatal risks, this measure is often expressed as ‘the average annual probability of fatality’ (Shrader-Frechette 1991:58). Risk is an event with a known probability, sometimes referred to as statistical uncertainty; true uncertainty is an event with an unknown probability, sometimes referred to as indeterminacy. In general, risk implies the *possibility* of some outcome i.e. an event, which is not predetermined. Therefore risk also implies *uncertainty*. Eugene Rosa’s 1998 definitions are: 'risk is a socially constructed phenomenon' (quoted by Slovic 2000:xxxvi);’risk is a situation or event where something of human value (including humans themselves) has been put at stake and where the outcome is uncertain’(Rosa 1998 quoted by Jaeger *et al.* 2001:17). This definition embeds the conventional definition =F x C (Frequency x Cost); it also permits risk to be good or bad (Jaeger *et al.* 2001:17). Regarding Risk Communication, we can generalise the definition proposed by Covello *et al*. (Jaeger *et al*. 2001:128-9 quoting Covello, Slovic and Winterfeldt 1986:172), in shortening it: ‘any purposeful exchange of information about risks between interested parties’.

2.2 Societal and Risk Concerns - Interdisciplinary Approach

Climate change and health care are good examples for the study; they require a multi-method, multidisciplinary approach (Slovic 2000:101). Climate change is similar to RF allocation in the uncertainty that damage will occur; both need decisions of policy makers and an interdisciplinary approach (Rayner and Malone 1998:xxxli); almost all climate change questions and concerns are equal to the problem of RF *human hazards*. The first suggestion for policymakers by Rayner and Malone (1998:109) is to view the issue of climate change holistically, not just as the problem of emissions reductions. Mental health promotion is a multidisciplinary endeavour, which works with people within their environment (Seedhouse 2002:45); there is a need to 'treat the whole patient' (Graham and Wiener 1995:242). The world is fundamentally interconnected (Seedhouse 2002:xiii). The first rule of ecology is that everything is connected to everything else (attributed to Barry Commoner; Seedhouse 2002:49).

Health care and health promotion are similar to RF allocation in these modes, since both:

– need prescriptive rules to achieve determined goals (Brennan and Berwick 1996:9, regarding health care);

– can be better explored through philosophy, understanding prejudice and applying it in practice (Seedhouse 1997:76-8).

Seedhouse (1992:54) asks what are the values (and morality) of health promotion, describing the different sorts of values, distinguishing those implementing ethics (1992:55-6). There are different methods of valuation: physical things, aesthetic qualities, intangibles (such as friendship), principles and ideologies (Seedhouse 1992:56).

The 'invisible hand' of Adam Smith, the economic theory resulting from self-interested[12] actors and the Weber Puritan ethic and religion are all inter-related (Jaeger *et al*. 2001:63). No single discipline has all the answers. Combinations of approaches complement one another's strengths (Slovic 2000:135). Leaving the ground solely to scientists will not solve risk problems; many risk conflicts have no technical solutions. Trying to address risk controversies primarily with more science is likely to exacerbate risk conflicts (Slovic 2000:411). Therefore, it is necessary to combine both science and knowledge gained from areas beyond science. By trial and error, society arrives at an essentially optimum balance between the risks and benefits associated with any activity; this is the 'revealed preference' approach to 'how safe is safe enough' (Slovic 2000:xxii and 80, referring to Starr 1969).

2.3 Quantitative Laws and Risk Thresholds

2.3.1 *Starr's Laws*

Quantitative laws could be useful to the thesis in analysing *societal* and *risk concerns*, exploring the RF *human hazards* (from cellular and electricity lines) and *spurious emissions* levels. Cost is also a societal concern; decoupling of issues invoking *societal concerns* from considerations of cost and practicality should be avoided; as shown in the results of Ball and Boehmer-Christiansen (2002:35-7). Acceptable risk for a new technology is that level of safety associated with ongoing activities having a similar benefit to society (Slovic 2000:45). By examining the relationship between risk and benefit across a number of common activities, the classic paper of Chauncey Starr 1969 discovered three tentative laws providing a quantitative instrument:

1. The public is willing to accept voluntary risks (e.g. skiing, handset RF exposure) about 1,000 times greater than involuntary risk (e.g. natural disasters, base stations RF exposure) that provide the same benefit[13].

2. The acceptability of risks appears to be roughly proportional to the real and perceived benefits, to the cube (third power) of the benefits.

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[12] 'It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their self-interest. We address ourselves, not to their humanity, but to their self-love, and never talk to them of our necessities, but of their advantage' Adam Smith (1776/1976:14).

[13] Slovic (2000:121-36) found that the data does not support the quantitative formulation; people are willing to accept high involuntary risks with large benefits; however, Slovic (2000:45,81) sets this useful law, with some drawbacks to this method.

3. The acceptable level of risk is inversely related to the number of persons exposed to that risk (more than 3 billions of cellular subscribers).

Starr disconnected between imposed risks and those accepted voluntarily. Starr, Rudman and Whipple 1976 proposed a numerical upper bound of 10^{-2} (disease, mortality rate) and lower bound of 10^{-6} (natural hazards) for the public's acceptance of involuntary risks. These numbers may be accepted as philosophical assumptions and speculations.

2.3.2 *De Minimis*[14] and Thresholds

"Zero risk is a quixotic goal, whether in poorer societies or in highly industrialized era" (Graham and Wiener 1995:147); Wildavsky 1990 titles it 'No Risk is the Highest Risk of All'. Regarding the decision criteria 'zero risk' as too stringent, one can constrain the level of risk that will be accepted. Thus, one might require that independent of the costs and benefits, the risk will not be allowed to exceed a specific level. Many concepts in common law, such as nuisance and reckless endangerment, are based on criteria of this sort (Morgan and Henrion 1990:27). An accepted level of RF *human hazards* or interference is the balance between the introduction of new technologies and protection of existing services. To define the allowed thresholds from cellular towers, power-lines and RF *spurious emissions*, the *de minimis* value is needed.

When coping with RF interference, we must define NOEL (No-Observed-Effect-Level) (Douglas and Wildavsky 1982:198 and Thompson 1986:118). This affects which power function is used, what size of test is run, which exposure-response model is employed and where the burden of proof is placed (Douglas and Wildavsky 1982:187). The same questions appear in the process of solving RF interference. It is a *de minimis* dilemma (negligible risk from *spurious emissions*, cellular towers and power-lines): society may declare a certain threshold, below which a hazard is judged to be negligible. The quantitative safety criteria are subjective and political (Jaeger *et al.* 2001:12); rational-based methods do not solve problems such as the level of unacceptable risk (Jaeger *et al.* 2001:118).

Like truth, risk is not absolute: 'there's no such thing as total proof, no such thing as zero-risk; better learn to live with it'[15]. For an example of 'zero-risk' extreme precaution, see the US Delaney clause (the Commentary of Slater in Lofstedt and Vogel 2001:413).

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[14] Latin for "of minimum importance" or "trifling". In risk assessment, *de minimis* refers to a level of risk which is too small to be concerned with.

[15] Times Magazine posted on 20/7/03 'Risky Business- Living with risk', pp. 40-7 http://www.time.com/time/europe/html/030728/story_7.html 27/02/08.

2.4 *Societal Response to Risk*

2.4.1 Social and Scientific Response to Risk

These are the societal questions on safety:

- What is our society willing to pay for safety? Chauncey Starr 1969;
- How safe is safe enough? Baruch Fischhoff, Paul Slovic P. and Sarah Lichtenstein 1978;
- Safety first, second, or by random selection? David J. Ball 2001a.

'Why the concern with human choice?' is treated deeply in Rayner and Malone (1998: xxxli). It explores issues of human needs, the social bases for cultural or institutional choices, uncertainty, imperfect knowledge and irrationality. Ball and Boehmer-Christiansen's (2002:40, table A1.1) propose different approaches to the control of environmental hazards. In this way, the environmental concerns serve as a source to explore RF.

2.4.2 Risk Tolerability

The attitude toward risk defines its tolerability and perception, and explains the conflicting approaches to national regulation of uncertain risks (such as RF *human hazards* and *spurious emissions*) and managing RF for innovation. The tolerance of risk is not a rational term; it is formed by the individual worldview. The willingness to accept risk varies among individuals, ethnic groups and regimes. Ball (2002a.: figure C1, originated from the British HSE- Health and Safety Executive) provides a helpful figure illustrating the risk tolerability.

2.4.3 Risk Perception

Paul Slovic has demonstrated with abundant clarity that risk magnitude alone is by no means the only factor influencing the level of concern about a particular hazard; 'the public is often seen to rely on *perceptions of risk* that are subjective, often hypothetical, emotional, foolish and irrational' (Slovic in Krimsky and Golding 1992, quoted in Ball 2002a.:62). Douglas and Wildavsky (1982) present risk perception as culturally constructed (see Burgess 2002:176). Even the definition of risk controls the rational solution of the problem at hand (Slovic 2000:411). The public and scientists are influenced by emotion, worldviews, ideologies and values (Slovic 2000:xxxvi). Worldviews may determine people's risk attitudes and perceptions (Slovic 2000:xxxiii,402; see also Dake 1991 and 1992); socio-political and psychological factors appear to similarly influence 'scientists' risk evaluations' and public perceptions (Slovic 2000:402-9).

Laypersons have the right to err; even and especially, victims (Shrader-Frechette 1991:218). Renn (Krimsky and Golding 1992:67) quotes Dietz, Frey and Rosa 1998 'Humans do not perceive the world with pristine eyes, but through perceptual lenses filtered by **social**[16] and

[16] The bolds in the quotations along this chapter do not appear in the original text.

cultural meanings transmitted via primary influences such as **family**, friends, super-ordinates and fellow workers'. The general public perceives unduly restrictive limits as an implicit recognition of severe risks. **Religious** faith (or a faith in the rules of history, such as Marxism) influences the thread of life and perception of risk (Kasperson J.X. and Kasperson R.E. 2001:431); therefore, religion may affect the thresholds of RF hazards.

The impacts of EMF[17] events remain limited in the social context, unless they are observed by human beings and communicated to others (Kasperson and Kasperson 2001:37). Psychological, social, institutional and **cultural** processes interact in ways that can heighten or dampen social perceptions of risk and shape individual, group and institutional behaviour (Kasperson and Kasperson 2001:35).

2.4.4 Social Amplification and Attenuation

The *social amplification* and "social construction" (Dake's 1992 title, Burgess 2002:175-8 and Burgess 2003:17) increase the direct risk effects quantitatively and qualitatively. It is necessary to include *social amplification* effects into risk analysis or decision analysis (Slovic and Weber 2002:18-9). 'In the case of mobile phone radiation, limited and otherwise ephemeral public concerns were amplified by institutional over-sensitivity' (Burgess 2006:333); risk governance embracing the projection of worst-case scenarios amplifies *risk concerns* and *societal concerns*. Risk perception is driven by individualisation, dissolution of beliefs, social institutions and practices (Burgess 2004:12,18).

The media serves as amplifier (Herman and McChesney 1997:49); the increasingly obsessed media contributes to EMF anxieties Burgess (2005:7-10). Interesting observation in this aspect: it is difficult to make an impact in the US with a single issue, due to lack of a widely read national press (Burgess 2004:187). Nishizawa (2005:19) also underlines the negative role of the '(conventional) mass media' distributing 'selective, sensationalised information'. The *social amplification* is pushed and rippled towards greater awareness by deliberative polling, national and local consultations, consultative panels, focus groups, citizens' juries, consensus conferences, stakeholders and Internet[18] dialogues, and government 'foresight' programs. The social processes can grow or shrink (in "risk attenuation").

Kasperson and Kasperson (2001:12, figure 1.1) portray the human interaction- how a single local point affects a province. Based on Kasperson and Kasperson (2001:36, figure 1.4) and Slovic and Weber (2002:13, figure 4), we can diagram the structure of *social amplification* using concentric ellipses; the innermost circle portraying the directly affected group, the

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[17] Electro Magnetic Fields (EMF), generated by cellular base-stations and electric lines.

[18] See Nishizawa (2005:20) on Internet 'transmitting negative information about science of EMF', and Burgess (2007:127,131) on mobile phones rumours spread by 'word of mouth' and circulated around the Internet.

outermost circle representing society and *societal concerns*. Figure 2-1 depicts the effects of conflict around a broadcasting station, cellular tower or power lines.

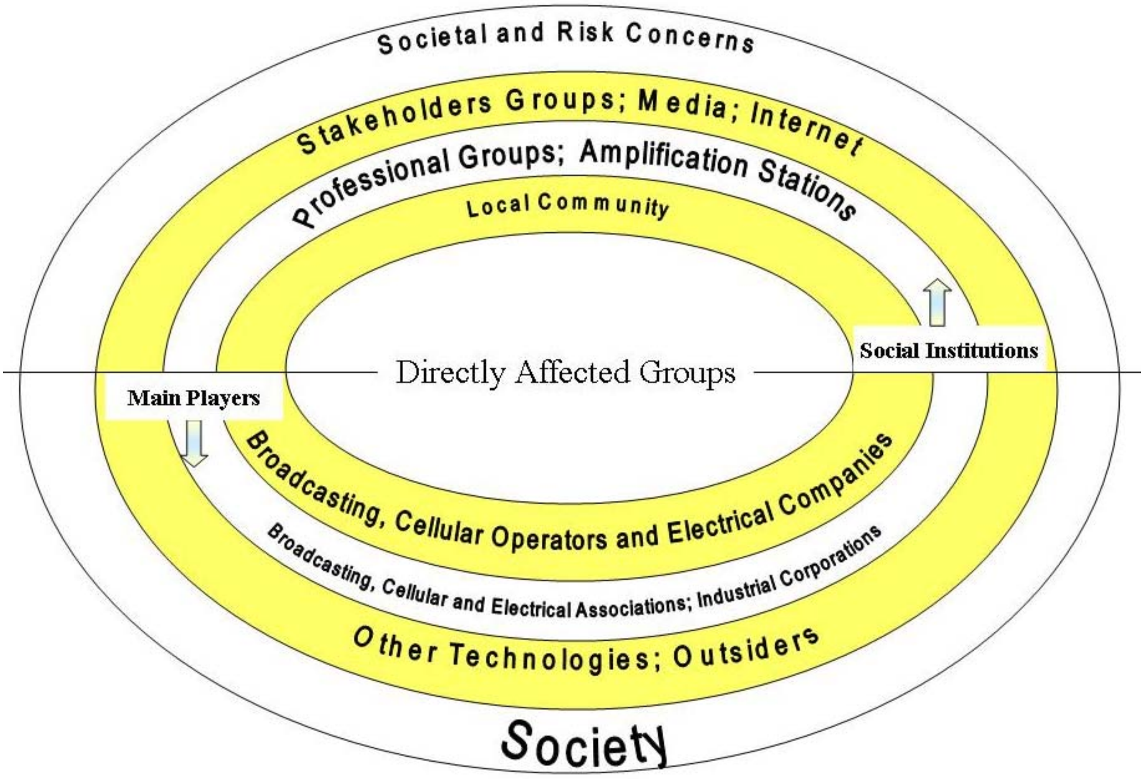

Figure 2-1 Ripple effects amplifying the Risk

3 The Global Allocation of the RF Spectrum

3.1 ITU and Global Communication

The adoption of international telecommunication standards and RF allocations is the original *raison d'être* of the ITU. When the European administrations wished to interconnect their national telegraph systems to form a continental network, the International Telegraph Union was created to serve as a forum for adopting standards which would allow that to occur (Codding and Rutkowski 1982:225). In the real world of competition among the providers of telecom equipment and services, the adoption of standards also represents a way of creating market opportunities (Codding and Rutkowski 1982:226-7, referring to Crane 1979). EBU (European Broadcasting Union) (Bulletin 15/7/1950:132-42) pointed out that a difference in standards is more a result of industrial and commercial interests than a technical consideration (Codding 1959:129).

3.2 International versus National Regulation

Robert Fortner points out (1993:85) that three principles (reserved frequencies for services, avoidance of interference and registration of frequencies) have formed the basis of international wireless communications (Hills 2002:106). The impossibility of operating a free market in the radio spectrum led to the acceptance of national regulations (Hills 2002:201). Fixed rules worldwide avoid divergence in individual countries due to social and cultural differences; national governments wanted flexibility more than they wanted standardisation (Hills 2002:14). If the communications infrastructure is a power resource, one might expect that control of international communications would reflect the dominant economic and political power structure of the day (Hills 2002:6). During the 1880s, nationalism became an increasing factor in world economic relations, and inevitably therefore in international communications (Hills 2002:67). In the period 1890-1924 a growth of distrust between nations and efforts to expand colonial possession were replicated within the communications sector (Hills 2002:89).

The expansion and technological upgrading of the Japanese network demonstrates that public control does not have to be antithetical to technological innovation (Hills 1986:204). Until 1981 procurement was from Japanese manufacturers alone; export was considered only after the domestic market was matured (Hills 1986:106,191). This may explain why Japan lost the international cellular market to Europe, where suppliers looked from the first moment toward an export market, e.g. Nokia and Ericsson.

New Zealand is the first country to apply the Wireless Act in 1903 (one year before the UK); the first RF Auction in the world occurred there in 1989. Neo-liberal ideologues promoted structural adjustment program which was more drastic than that inaugurated by Margaret Thatcher in Great Britain (Herman and McChesney 1997:178-9). Their 1987-1991 auction of UHF spectrum resulted in the acquisition of RF (Herman and McChesney 1997:180).

3.3 Geography: RF Allocations to Three Separate Regions

3.3.1 The Foundation of the Geographical Separation

The telegraph is the source of today’s communications and of the Wireless Telegraph Acts, which are still highly valued nowadays. During the 19th century, Austria and various German states came together in a loose grouping known as the 'Austro German Telegraph Union', and the Western European states in turn were amalgamated to become the 'Western Telegraph Union.' Napoleon III called a conference in 1865 to draft a treaty that would eliminate the discrepancies between the practices of the two groups (Codding and Rutkowski 1982: Introduction); the *International Telegraph Union* (ITU) was established. This was the first international organisation within telecommunications, and the first separation between East and West in this field. Since 1865, there are periodical ITU plenipotentiary and radio conferences to get the strategic and radio decisions; in the last decades these conferences are held every four years.

Among the general topics discussed at the 1928 conference were the difficulties in attending to a country's needs: technical and physical conditions, e.g. propagation, characteristics, topography, **geography**, **longitude**, **latitude** and climate; moreover, political and **social** characteristics, such as the importance of broadcasting as an instrument of government, customs, **languages**, political subdivisions, and existence of minorities (Codding 1959:94). Interestingly, at the RRC-2006, one may see that the concerns have remained much the same, despite the passing of years.

3.3.2 Longitude: the three ITU Regions

The division between Europe and the 'other regions' is the root of the different RF allocations in the ITU Radio Regulations, and standards in Europe and America. Through the efforts of the ITU and its predecessor, the International Radio Telegraph Union, most of the usable part of the spectrum has been divided among various radio services (Codding 1959:80). The three ITU Regions are: Region 1 which includes Europe, Russia and Africa; Region 2, which includes the Americas; and Region 3, encompassing Asia and Oceania (Codding and Rutkowski 1982:70,259).

These are the phases of the longitude separation into three ITU Regions:

─ In 1906 in Berlin, 29 countries under the guidance of the Germans, drew up an International Radiotelegraph Convention and annexed the Radio Regulations, following the example of the International Telegraph Union (Codding and Rutkowski 1982:13).

─ In 1927 at the Washington ITU conference, different allocations across the Atlantic were discussed; in particular concerning frequencies above 25 MHz. European countries held that all frequencies between 25 and 200 MHz should be allocated on a worldwide basis for specific services. However countries in the rest of the Western Hemisphere expressed opposition to this view. They first pointed out that the countries of Europe and the Western Hemisphere (America) were using these frequencies for different purposes; secondly, they considered that the use of frequencies above 25 MHz was still in such an experimental state that only temporary allocations of these frequencies were advisable (Codding 1959:82). Therefore, for the first time, it appeared to be a case of West versus East: the US against Europe. Europe wanted worldwide allocation, and America wanted to operate the new RF bands above 25 MHz.

─ The Brussels 1928 ITU conference established the division into distinct regions, by confirming there would be a different channel separation in AM broadcasting: 9 KHz in Europe and 10 KHz in America (Codding 1959:93). The only contentious issue raised in the American ‘Rio de Janeiro 1981 agreement’ was whether to adopt the 9 KHz channel spacing common to the rest of the world, or to remain with the 10 KHz spacing in the Americas; it opted for the latter (Codding and Rutkowski 1982:52). The 10 KHz versus the 9 KHz channel separation of AM broadcasting is the first major difference between Europe and America; it remains until today.

─ The ITU conference held in Madrid in 1932 divided the RF above 30 MHz into two parts, a European region and 'other regions' (Codding 1959:84). For the European region specific permanent bands were allotted to meteorological aids, TV, broadcasting, air services, amateurs, and fixed and mobile services. The American countries annexed an experimental table to the Cairo Radio Regulations for frequencies ranging between 30 to 300 MHz, as a possible guide for further development.

─ At the first combined ITU Administrative Telegraph and Telephone Conference and Administrative Radio Conference held in Cairo in 1938, two HF Broadcasting allocations were made in spite of the US' opposition to this initiative. The priorities in Europe (preferring nationalised collective broadcasting) and in the US (favouring the individual amateurs) are diverse; it is also interesting that the US has traditionally supported the Mobile service (land, aeronautical and maritime) over broadcasting, and continues to do so until today. Thus, since 1938, dissimilar allocations have been introduced in Europe and America deriving from the different preferences on either side of the Atlantic. Regarding the RF operated by amateurs and broadcasting, an interesting geographical argument was proposed: 'Difference in time will prevent interference broadcasting and Amateur' (Codding 1952:166): the difference in longitude causes a time variation between the continents; thus enabling co-sharing in the frequency domain due to the time separation across the Atlantic Ocean.

─ The Atlantic City ITU conference (1947) continued the policy of breaking down allocations in non worldwide bands into regions (Codding 1959:85). In addition, the former twofold classification agreed upon in Cairo in 1938 was replaced by a threefold one: Region 1, approximately comprising Europe, Africa and the USSR; Region 2, the Western Hemisphere; and Region 3, the remainder of the World (Near East, Asia and Oceania).

─ The Cairo meeting (1938) allocated frequencies ranging until 200 MHz, and the Atlantic conference allocated those until 10,500 MHz (Codding 1959:85). Because their propagation characteristics were of a limited range, it was possible to prevent a major dispute by dividing some of the frequency in the 25 MHz to 200 MHz range into a European Region and 'other regions' (Codding and Rutkowski 1982:20). The Europeans were thus allowed to assign portions of the frequency band to specified services, and the US was free to be flexible in the use of the entire band.

3.3.3 Geographical Latitude and Wireless Communications

At the Cairo conference in 1938, three HF bands (2300-2500, 3300-3500 and 4770-4965 KHz) were allocated to broadcasting in **tropical** regions, where adverse atmospheric conditions take place (Codding 1952:165). The conference allocated special bands to guarantee more reliability in short distance broadcasting than the lower HF frequencies, which are severely disturbed by conditions specific to **tropical** zones (Codding 1959:87). For the first time, a difference in allocation was rooted in reasoning of geographical latitude (and not longitude).

RF regulation and standards depend also on neighbourhood: Canada is linked by ties of ownership, corporate interlocks, joint ventures, syndication and participation loans: 'miniature replica' of the dominant continental power (Herman and McChesney 1997:157). Codding (1959:104) provides a pictograph of Radio Receivers per 100 people around the world, between 1949 and 1956; the figure depicts the underdevelopment in these years in Africa, Asia and in the tropical countries.

3.3.4 Geography influences Regulation: Population Density and Location

The variation of densities in Europe (Japan) and the US is significant to the diverse RF allocations, wireless applications and even to the TV and Cellular standards development (see the RF introductory section on new digital TV modulation and cellular mobility). The US insisted that each country should be free to assign RF to any service; this provision left all problems of interference in Canada and Mexico to be sorted out bilaterally and proved unworkable in Europe[19] (Hills 2002:205, quoting Luther 1988:29 and Tomlinson 1945:159). The US concerns were quite different from those of the landlocked European countries, throughout a fragmented continent (Hills 2002:279). In contrast to Europe, where the small size of countries prevented the domestic use of shortwave for broadcasting, the large landmass of the US allowed shortwave to be used during the 1920s, to link radio stations that were far apart (Hills 2002:264). The UK is favoured by its geographical location: HF emissions from the Rugby relay station reached the various parts of its empire (Hills 2002:211, citing Appleton *Empire Communication* 1933:12).

3.3.5 Summary: Geography and RF Allocation

For the thesis, the influence of geography on RF allocation is central. The International Radiotelegraph Conference in Berlin in 1906 formed the Radio Regulations; these regulations are the official RF allocations for every country; ITU-R does not intervene in regional or national licensing. The ITU conference in Cairo (1938) divided the RF

[19] As there are much more countries in Europe than in North America.

allocations between Europe and 'other regions'; the separation Europe and America is essential to explain the divergence in RF regulation and standardisation; the transatlantic difference is still prevailing. The Atlantic City conference (1947) established the three ITU Regions; only in the second part of the 20th century (Japan) and in the 21st century (China), the third Region Asia contributes to specific RF allocation and standardisation. The division into three ITU Regions is derived from different priorities in RF allocation and different markets for the industry. In addition to longitude (continents), latitude settles the tropical HF allocations. Proximity to the coastline may positively affect the growth of communications. Neighbourhood causes more influence on regulation and standards. The variation of density and expansiveness in Europe versus America yields a diverse regulation and standardisation across the ocean.

3.4 Languages and Colonialism Influencing Global Communication

The examination of language in international communication provides an interesting viewpoint as to the colonial roots and the role of language in culture and political relations. There are between 2,500 and 2,700 languages spoken in the world today; of the total number of languages, between 1% and 3%, about 82 languages, are spoken by 96% of the world population (Mowlana 1996:104). Mowlana continues: with the formation of the modern nation-state system, language usually became synonymous with nationality. For instance, English, French, German, Spanish, Danish, Dutch, Italian, Portuguese, Chinese, and Japanese were simultaneously languages, nationalities and nation-states. In contrast, the new countries of Latin America spoke Spanish, but were neither of Spanish nationality nor Spanish states; the same held true for the French, English, German, and Portuguese colonies of Africa; the English colonies of America spoke English, but fought to become independent states (Mowlana 1996:105). With a few exceptions such as Canada, Cameroon, Belgium and Switzerland, very few bilingual or multilingual states give equal footing to more than one national language (Mowlana1996:106). Language is not invisible but constitutes an active force in international relations (Mowlana 1996:106). Language and culture are a result (e.g. of colonialism) rather than a primary cause (of standards' adoption); there is a close relationship between the structure of the language and the conceptual categories that govern the behaviour of native speakers of that language (Mowlana 1996:109). Language is an expression of human existence; one can regard language as the bearer of subject matter in itself (Mowlana 1996:110). In a very general sense, one could consider language to be almost identical to mind and to culture; in this sense, language is both a significant system in the creation and distribution of power and a pivotal medium in global communication (Mowlana 1996:110).

There is a reinforcement of the dominant culture by its success and power, as an economic-political-cultural force (Herman and McChesney 1997:155); "Strong cultures with linguistic barriers to Western intrusions, like Japan, withstand cultural penetration" (Id.). 'Differences in language are obstacles to understanding and communication but not unsuperable ones' (Glenn 2004:48). Therefore, the same language shortens cultural distances, but different languages may create a barrier to 'import' RF rules and standards. Rhonda Crane highlights the role of the language (and colonial heritage); the determination, as to which colour TV systems countries favoured, was based to a large measure on whether nations shared old colonial ties, linguistic and cultural unity, or similar political philosophies with one of the countries promoting a system (Crane 1979:75). Crane continues, explaining that Russia carried along the Eastern European bloc in the vote for SECAM, while France was able to swing the support of African Francophone countries for this system. Agreement on compatible standards in international organisations is also hampered by differences in language (Crane quoting Ainsworth 1964:365); the need for interpretation facilities raises costs and tends to make the scheduling of frequent meetings impossible (Crane 1979:9). Diversity could also create problems in exchanging programs, for countries with cultural and linguistic diversity- Belgium, Switzerland, Northern Italy, border regions in France and Germany (Crane 1979:12, referring to Paulu 1970:34). France had to convince undecided countries (Third World and French-Speaking) to support SECAM (Crane 1979:74). Canada has had the fortune, good or bad, to abut the US and to share a common language (except for the 20 percent minority of a French-speaking population). The US long ago replaced Great Britain as Canada's main cultural and economic link, and in fact has gradually assumed a position of economic, political, and cultural pre-eminent influence, if not domination, over the smaller power. This rests…on economic integration (Herman and McChesney 1997:156).

The Six official Languages of the ITU Correlate RF Standards to Culture

Language is crucial to characterise culture. The official language of many countries is a colonial inheritance. The delegate in conferences or industrialist feels comfortable using his/her own language in regulation or trade; his/her country's administration tries to advance its use; language adoption in the ITU reflects the geopolitical power of the country and its authority over ex-colonies. Some ex- colonies follow the rules of their colonisers. Today the six official languages of the ITU are Arabic, Chinese, English, French, Spanish and Russian. The six languages all have equal footing within the organisation (ITU Plenipotentiary Resolution 115, Marrakesh 2002). These languages serve the thesis as a tool, to correlate RF standards to culture.

3.5 Case Studies of the Thesis: UK, France, Europe and the US

3.5.1 Centralised France leading collectivised harmonisation

The first French initiatives in telecommunications for collectivised harmonization were revealed in Paris in 1855 (at the 'Western European Telegraph Union'), then at the 1864 Convention and at the 1865 ITU first meeting. In 1864 the French imperial government invited all the major European countries to attend a conference in Paris to negotiate a convention which would provide for **uniformity** in the international telegraph system (Codding 1952:20). France obtained agreement in 1865 to designate the French Franc as the monetary unit for the payment of international accounts (Codding 1952:22); the 1885 Berlin Conference reconfirmed this decision (Codding 1952:75).

The French 'command and control' approach is exemplified by their request (*circa* 1871) that the ITU director should be placed entirely under the direction of a telegraph administration (Codding 1952:49). The collectivised French attitude versus the US individualism is illustrated by France's fear that as a result of the creation of the ITU CCIR[20] in 1927, private companies would obtain the approval of the committee and use it for commercial gain (Codding and Rutkowski 1982:86). This is an illustration of the French culture influencing their regulation policy; the French worldview influences till today the European and global regulation toward top-down harmonisation.

Comparing strategies - the 'core' liberal ideology of the US is in accord with its decentralised state and liberalisation of telecommunications; the 'mercantilist' ideology' of Japan and France is in accord with their centralised states (Hills 1984:240,266). 'The French have also used central government power to direct effort into exports'… 'The highly centralised administrative system in France creates conditions favourable to the central direction of demand and supply' (Hills 1984:242).

3.5.2 The TV Colour standard SECAM as a new French Cathedral

'The French state has a well-founded reputation for authoritarianism going back to Colbert and the first Empire; the 'statist tradition' has been characterised by economic interventionism, and by a resistance to the free play of market forces' (Crane 1979:37). 'It has also been marked … by the affirmation of superiority of the state over other economic entities in the determination of the general interest' (id. quoting Michalet 1974:107). Crane (1979:5) quotes Gilpin (1967:7) stating that the goal in France was 'to make science an instrument of French economic, military and political objectives'. The standard is identified with that country, symbolising the nation's power and progress through technology (Crane

[20] *Comité Consultatif International de la Radio*, the former name of ITU-R.

1979:7). In SECAM France has achieved patriotism and loyalty (Crane 1979:49). SECAM is a national champion: national independence against the world's foremost scientific power, the US (Crane 1979:38, quoting Gilpin 1968:36). The history of France has been a history of technological innovation and technological spectaculars, of new **cathedrals** [Vichney N. *Les Nouvelles Cathédrales* (1974:1,11)]; e.g. Concorde and SECAM (Crane 1979:39). In the thesis the French 'cathedral' will be contrasted to the US 'bazaar'. Crane continues: the De-Gaulle administration raised large-scale technological developments - which epitomised the glory, prestige, and independence of France; however, with huge economic and political costs. SECAM is a badge of political prestige: a winning domestic technology, spread around the world; a lucrative venture (Crane 1979:45). Through SECAM, France had increased its possibilities to expand its sphere of influence in other directions, and closer cooperation with the '*grande technique francaise*' (Crane 1979:46).

3.5.3 The US Individualism

The American individualism versus the European collectivism is well exemplified by the typical remark of an American observer at the St. Petersburg Telegraph Conference in 1875: the interests of the public who use the telegraph seemed to be entirely subordinated to the interests of the state and to the administrations (Codding and Rutkowski 1982:8). The US never became a member of the Telegraph Union. The US refused to become a member of the ITU till 1 July 1908, because the US telegraph and telephone services were provided by private enterprise (Codding and Rutkowski 1982:16). At the Atlantic City Conference in 1947, the US stated its reservations about Member States being bound by the administrative regulations (Codding and Rutkowski 1982:21).

The US traditionally supported the mobile communications and the amateurs[21], instead of broadcasting. By 1910, amateurs' stations outnumbered commercial and governmental stations by four to one (Hills 2002:107, quoting Douglas 1987:207); this is one of the reasons that the US prioritised the Amateur over the Broadcasting service.

The US emerged from the Second World War stronger than ever (Herman and McChesney 1997:16 and Hart 2004:228). Relatively unscathed by the war, the US initiated the post-war collaboration in the field of telecommunications in Atlantic City in 1947 (Codding and Rutkowski 1982:21). The internal political threats to market freedom may be reduced further by international accords; for example, the Canadian-US Free trade agreement of 1988 and the NAFTA agreement of 1993 pulled Canada and Mexico more closely into the global as well as regional system, reducing the freedom of the relevant populations to interfere with

[21] Favouring the Amateurs in the US can be indirectly related to geography: natural disasters might be more frequent in the US, relative to Europe. For more than 100 years Amateurs assist to rescue.

cross-border market decisions (Herman and McChesney 1997:151). It is important to note that the US is dominant in the microprocessor and software industries (Hart 2004:226), leading the field both in hardware and software; but in contrast they do not hold the same position in TV or cellular production.

3.5.4 The US Communications and the US Sphere

The US applies minimal domestic regulation (Hills 2002:283); this is a significant observation running through the entire thesis. Private US companies dominated the ITU RF allocation (Hills 2002:18). The US delegation to the Cairo conference (1938) opposed the worldwide allocation proposals of UK, France and Germany. John D. Tomlinson concludes that 'the Havana (1937) allocations were made in a view to prevent a universal allocation of these frequencies which might be contrary to the interests of the US' (Tomlinson 1945:251, quoted in Hills 2002:214-5). Therefore, the US was the reason for the separation into ITU Regions, away from the position of UK, France and Germany.

In the 19th century South America was still very much under Portuguese, French and British cultural domination; however, in the interwar years the US dominated the infrastructures of the major South American states (Hills 2002:18). The US pressed for nationalisation of radio in Latin America in order to prevent European control of the hemisphere's international radio communications (Hills 2002:215). After Second World War the entrenched model of the US commercial broadcasting in Latin America eased the penetration of US network TV (Hills 2002:271, quoting Fejes 1979:74). This fact is important in explaining the adoption of the US Black and White TV standard, 6 MHz bandwidth, field frequency of 60 frames per second, and radio channel separation by many countries in South America, and later the US analogue colour NTSC standard.

3.5.5 European Communication and Europe versus America

The European Community (EC) was organised years ago in an effort to reduce intra-European tensions and to increase Europe's economic strength by means of regional trade integration (Herman and McChesney 1997:30). The Treaty of Rome reflected the German interest in free markets and the French interest in retaining planning instruments at national levels only (Hart 2004:122). This thesis describes how the French/ German engine conducts European activities in RF regulation and standards.

European culture dominated in South America before the Second World War (Hills 2002:157). The methods by which national governments have been able to control their domestic economies have been weakened through GATT (General Agreement on Tariffs and Trade) and, in the case of member countries, by the EEC (European Communities

Commission) (Hills 1984:265). There is competition between Europe and the US, between the unbridled, capitalist free-market ideology of America and the desire of others to have a more socially equitable method of distributing the benefits of telecommunications (Hills 1986:206). The US government regards the ITU as a European organisation; the FCC is frustrated as it holds no 'national interest' other than the various companies' interests; what particularly concerned the FCC was a system of competition and separation of technologies (Hills 2002:218).

Summary: *Case Studies* of the Thesis (UK, France, USA and Ecuador)

France, UK, Germany, Russia and the US are the most active administrations in ITU. France, UK and Germany shaped the European RF regulation; the US took the lead for the American continent and established the RF allocation in the Americas. Since the beginning of communications, Europe and America have proceeded along different paths; the RF allocation and regulation is divided mainly between these two continents. The minimal domestic regulation in the US and the centralised ideology of France are significant factors, running through the entire thesis; the *case studies* will provide illustrations relevant to the wireless communications.

France strives for harmonisation and central-planning, at least in Europe; the French collectivism led France to initiate the first ITU conference and top-down RF regulation. France emphasises state intervention and top-down central-planning, e.g. building the SECAM 'cathedral'. The US leads the individualised worldview. The UK stands between France and the US: like France, promoting the nationalised broadcasting service, but also like the US, supporting the mobile service, mainly for maritime use. World Wars I and II have strengthened the power of the US and weakened Germany also in ITU; Russia became significantly more influential after 1945. Europe preferred a worldwide allocation, the US separated in ITU the allocations to the Regions.

3.6 Adoption of Analogue and Digital TV Standards

3.6.1 Analogue TV Standards

Once a TV analogue standard has been adopted by a nation, it is an expensive matter to change; it is a long term political commitment. In the real world of competition, the adoption of RF standards also represents a way of creating market opportunities. Focusing on the adoption of colour television standards in France, Rhonda Crane notes the degree to which technical standards are the result of political and economic phenomena and demonstrates how small technical differences are exploited for large gains. National agendas and industrial policies played a major role in derailing the ITU CCIR negotiations from their original purpose. Lack of authority, poor coordination between international entities, formation of regional blocs, and **language** difference contributed to hamper the negotiations and agreement on standardisation of colour television (see also Dupagne and Seel 1998:9-10).

The adoption of compatible standards reveals political objectives at a national level. The determination, as to which colour TV systems countries favoured, was based also on old colonial ties, linguistic and cultural unity, or similar worldviews. The 50 or 60 cycle power supply and Black and White technology guided countries toward their TVs choice. Africa, Mideast, and Southeast Asian countries favoured the standards existing in Europe.

In the thesis, the French concentrated central-planning is associated with the top-down cathedral (such as SECAM and GSM); and the US decentralised, distributed, market-based worldview is categorised as the Internet and Wi-Fi 'bazaar'[22]. The competition PAL/ SECAM versus NTSC is between Europe and the US; the discord about the adoption of TV standard is typical of other disputes across the Atlantic. Crane reveals the competition within Europe, namely Germany/ UK against France, and between the US and Russia (the Cold War): USSR preferred the French standard over an American one.

3.6.2 Digital TV Standards

The globalisation of culture has been made easier with the rise of the Internet and digital delivery of video images (Hart 2004:242). In the US, the development of digital TV signals was a direct descendant of formatting files in the World Wide Web (Hart 2004:220). The Japanese public broadcaster, NHK, led the Japanese electronics companies in the creation of new technologies for HDTV production, transmission and reception; however both the Europeans and the Americans rejected the Japanese approach to HDTV (Hart 2004:222). Influential groups in Europe and the US perceived the Japanese proposal to be part of a general effort to consolidate Japan's global position of hegemony in consumer electronics and therefore proceeded to block the initiative (Hart 2004:97,119). Nationalism - or regionalism in the case of Western Europe - combined with digitalism, produced three different HDTV standards in the three regions (Hart 2004:230). The major industrial nations structured their TV broadcasting institutions in a divergent manner: particularly the split between the dominant public broadcasting systems in Europe and Japan, and dominant private broadcasters in the US (Hart 2004:224).

3.6.3 Summary: Analogue and Digital TV

In the 1960s Europe did not succeed in adopting a single European colour TV standard; whereas thirty years later Europe adopted a unified digital TV standard, the DVB-T. In the late 1980s and 1990s, Japan, the US and Europe considered replacing the existing analogue

[22] See the author's ITU-T presentation as the chairman of the Regulatory issues, Mazar2004http://www.itu.int/ITU-T/worksem/asna/presentations/Session_7/asna_0604_s7_p1_hm.ppt19/12/07 contrasting also RF license exemption and Internet.

television infrastructure with a new digital one. Nationalism and regionalism produced three different and incompatible standards. The outcome has led to missed opportunities in developing a global digital TV technology. It can be compared to the three incompatible analogue colour TV standards - NTSC, PAL and SECAM. Rhonda Crane and Jeffrey Hart clarify how culture and geography affect the development and adoption of analogue and digital TV standards. The identification of countries with particular colour TV standards (SECAM- France, PAL- Germany/ UK, NTSC- the US) is similar to the association of the digital TV standard DVB-T with Europe, ATSC with the US and ISDB-T with Japan.

3.7 Summary: Global Allocation of the RF Spectrum

The national regulation and standards reflect the geography, the culture and also the dominant economic and political power structure of the day. The present standards are shaped by the framework formed by earlier struggles. Europe and America are the dominant communications powers. The two 'spheres of influence' are accepted. The US is leading the regulation in the Americas; the UK, France and Germany conduct the European rules. Nationalism and distrust between nations are factors in international communications.

4 Theoretical Approaches

Cultural Theory, *Bounded Rationality* and *Rational Field Theory* will be used to analyse the phenomena of allocating RF bands and issuing licenses. The three theories will explain the global empirical data, the different rationalities and risk tolerability.

4.1 Cultural Theory

4.1.1 Plural Rationalities

In terms of sociology, *Cultural Theory* is helpful in understanding why issues (like wireless telecoms, or genetically modified crops) generate the kind of arguments they do. Mary Douglas and Aaron Wildavsky originally propounded *Cultural Theory*. More recently John Michael Thompson and John Adams have taken up the flag. *Cultural Theory* does not reject rationality, instead it acknowledges plural rationalities; where the science is inconclusive the imagination is liberated to speculate rationally from different starting assumptions. Further, this approach limits the contending risk regulation regimes to a comprehensible and manageable number. Going back to the Greek roots of classification, we may choose not to follow the teachings of Plato's Republic which suggest the exclusion of the individualists and egalitarians entirely; as he externally imposed restriction on choice, in the two-dimensional sociality grid. We may prefer Aristotle's idea that it is essential for good government, pluralism and the balance of political cultures, or at least 'never entirely excluded' (Thompson, Ellis and Wildavsky 1990:64).

4.1.2 Four prototypes of *Cultural Theory*

Cultural Theory classifies the four perceptual prototypes (see Adams and Thompson 2002:8-9). Figure 4-1 illustrates the four prototypes, explored also in the section 'Hood's Typologies of Organisations and Attitudes to Risk'. The collectivised and individualised are underlined, as the research analyses the four prototypes, and additionally converges to two prototypes (see also Hood *et al.* 1999:45).

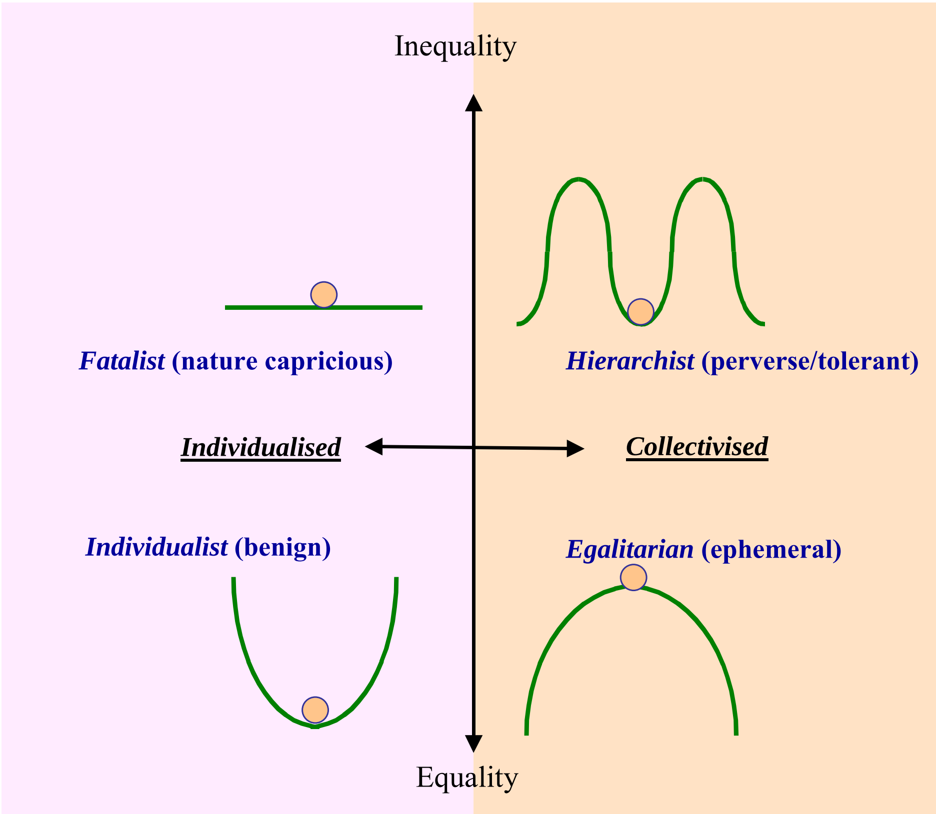

Figure 4-1 Typology of perceptual filters (Schwarz and Thompson 1990:5)

The research uses the four prototypes to characterise the different *societal* and *risk concerns* of countries. The *Cultural Theory* prototypes usually illustrate the perception of risk toward nature, namely, 'myth of nature'. Armed with this model, instead of exemplifying the tolerability of nature to risks (such as climate changes), the ball (see Figure 4-1) in our case depicts the conception of human health, and the tolerability of our body (to RF radiation), using the same four prototypes. Similar analysis also fits the health of wireless systems; their health is threatened by *spurious emissions*; so, the same illustrations also fit the tolerability to risk of the RF receivers (from unwanted emissions).

Rayner and Malone (1998:volume 3) include important analysis: *Cultural Theory* is used to predict fertility controversy, population growth and numbers. Greif (1994:931,943) proposes that *individualist* cultural beliefs create more efficient inter-economy relations, are more efficient and foster initiative and innovation. Rayner and Malone (1998:361) specify the characteristics of perspectives (myth of nature, human nature, type of management, driving value; attitudes to needs/ resources and risk) of the Hierarchist, Egalitarian and Individualist.

It is interesting that the Fatalist (Nature capricious) doesn't appear in the table. Can we agree with eliminating the Fatalist, as he/she does not contribute to the solution (i.e. he/she will not vote)? Perhaps the most prominent source of narrow decision-making is the so-called absent, 'omitted voice' or the 'forgotten groups' (Graham and Wiener 1995:130). The NIMBY (not-in-my-backyard) attitude is also a kind of omitted voice - shifting hazardous waste (risk transfer) to less powerful neighbourhoods (Graham and Wiener 1995:233).

4.2 Bounded Rationality

4.2.1 Economics, Finding Good and the Rational Way

In many situations, committees must decide how to allocate a divisible good - one that can be broken up in any number of ways (Jones 1998:16). James G. March 1991 ('Social Science and the Myth of Rationality', quoted by Jaeger *et al*. 2001:155) summarizes this excellently: 'because there are costs to act rationally, it is rational not to do so'. Therefore a question to pose is: do we really need to be absolutely rational in regulations and in adopting standards?

In his second and most famous work Adam Smith (1776 *Wealth of Nations*) argued that a free-market economy was the economic order best suited to human nature. His work is commonly associated with two phrases: the 'invisible hand' and '*laissez faire*'. Most importantly his work demonstrated the power of Rational Action in explaining phenomena such as market dynamics (Jaeger *et al* 2001:41). However, although Adam Smith's 'invisible hand' assures that markets do an efficient job of delivering the goods and the services people desire, it tells us nothing about people desires; culture shapes tastes, and if market forces shape culture, then the invisible hand is 'untethered' (Frank and Cook 1995:201). The *Bounded Rationality* analyses the bounds of classical economics and the *Rational Field Theory* adds desires and beliefs to the decision-making process.

4.2.2 Objectivity and Rationality in Risk

Risk assessments are like judgments in aesthetics (Douglas and Wildavsky 1982:187,191). Any form of life 'can be justified', since all people are biased in their perceptions of danger (Shrader-Frechette 1991:32-4); the bias may result from culture and geography originating different beliefs and values. Risk is subjective; this is the opening phrase in Adams and Thompson 2002. Douglas and Wildavsky (1982:73) stated that subjective values must take priority when choosing between risks; choice requires selection, and selection demands judgement; not only about what is but what ought to be in the future (1982:84). Risk management is related to the rational way we think; decision-makers operate in uncertainty. Risk and uncertainty limit the rationality, as they appear in the demand function, cost function, or both economic functions (Simon 1982:410). Rationality is the basis of *objectivism:* the item is what rational actors believe it to be. However, by taking account of the *societal concerns* about risk, we may abandon *objectivism;* thus, risk is subjective and refers to a future that exists only in our imaginations (Adams and Thompson 2002:12). Plural responsiveness to risk requires a search for optimisation, between incompatible sets of values and beliefs. Satisfying rather than optimising is then propagated as the 'boundedly rational' choice process (Mantzavinos 2001:53, based on Sargent 1993).

Vested interests are impugned in controversies over the management of risk; one of the drivers of vested interest is material gain. However, many other factors may contribute, including status, professional cultures, homespun ideologies, and so on; all of which influence the positions adopted by individual agencies and the measures to which they subscribe (Sapolsky 1990, cited by Ball 2001a.:1); Robert V. Smith (2007) titles it 'Where You Stand Is Where You Sit'.

4.2.3 Toward Bounded Rationality

A relative truth might elucidate the subjectivity of risk and introduces also the relative rationality; thus setting up the framework of four different rationalities of the *Cultural Theory* and guiding toward the *Bounded Rationality*. Traditionally, economic theory has relied on the assumption that a *homo œconomicus* exists, whose behaviour is governed by self-interest and who is capable of rational decision-making. Economic research assumes that people make decisions in a rational way.

Given that we are rational or at least should be, the last two decades has shown that there is a *Bounded Rationality* even in the economic sciences. Recent psychological studies (e.g. Kahneman 2002:460 and Kahneman, Wakker and Sarin 1997) have shown that basic postulates in economic theory should be modified; the rationality is bounded; the utility depends on risk to lose and the history of adaptation to prior stimulation.

1) The economist Vernon L. Smith, the laureate of Nobel Prize 2002, published (Smith 1962) that only under perfect competition, the market price establishes equilibrium between supply and demand- at the level, where the value assigned to a good by a marginal buyer is as high as that of a marginal seller.

2) The psychologist Daniel Kahneman, the laureate of Nobel Prize 2002, refers to the cognitive layer - less conscious factors that also govern decisions in an interactive process (Kahneman, Slovic and Tversky 1982). Such elements include perception, mental models for interpreting specific situations, emotions, attitudes and memories of earlier decisions. Based on surveys and experiments, the assumption of economic rationality in some decision situations is called into question. Real-world decision-makers (like other individuals) frequently appear not to evaluate uncertain events according to the laws of probability; nor

do they seem to make decisions according to the theory of expected-utility maximization. People, including decision makers, are incapable of fully analysing complex decision situations when the future consequences are uncertain. Under such circumstances, they rely instead on heuristic shortcuts; the fundamental bias is illustrated by experimental data on the way individuals judge random events. In situations with uncertainty, human judgment often exploits rules of thumb, which systematically contradict fundamental propositions in probability theory. When faced with a sequence of decisions under risk, individuals thus appear to base each decision on its gains and losses, in isolation rather than on the consequences of a decision for their wealth as a whole. The results contradict predictions from the traditional theory of expected-utility maximization (Kahneman and Tversky 1979).

We would expect that the self-interest material incentives would enforce rational behaviour. However, even in economics we don't find total rationality; the rationality itself is bounded. Therefore, why expect and seek complete rationality from people who regulate RF allocation under uncertainties? Moreover, the 'relational distance' between the Rationality and *Bounded Rationality*, and the cognitive layer elements (such as perception and attitudes) depend on culture and geography; they affect wireless regulation, risk tolerability and RF licensing.

Culture and geography may bound the Rationality. *Bounded Rationality* refers not only to individuals, it refers to organisations too; as made clear in Graham and Wiener (1995:235-7), for example. A powerful source of risk tradeoffs is rooted in the structure of organizations, e.g. the fragmentation of decision-making into specialized roles with bounded oversight responsibilities (1995:235). The bounded oversight structure appears in government (1995:236). Bounded specialisation in decision-making about risk is similarly rampant (1995:237), and also tends to blind the decision-maker to information about risks outside his or her jurisdiction (1995:238). Bryan Jones (2001) also refers to the *Bounded Rationality* in governance; he links the behavioural foundations of human nature to the operation of large-scale organisations. Mantzavinos (2001:55) relates the *Bounded Rationality* of individuals to the subjective rationality of institutions: *homo sociologicus* versus the *homo oeconomicus*.

'Subjective Rationality'[23] may cope also with the unacceptable level of risk and Maximisation of Expected Utility; since it can incorporate subjective preferences. A blind pursuit of instrumental rationality has led to disastrous results and is morally irresponsible; a broader form of rationality is needed, based on constructing consensual agreements on values, interests and beliefs (Jaeger *et al*. 2001:242); see also Seedhouse (1992, 2001, 2002 and 2003) referring to values and beliefs.

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[23] In 'Subjective Rationality' an agent is rational when he/she acts according to subjectively 'good reasons'; Mantzavinos (2001:53).

4.3 Rational Field Theory

4.3.1 Society as a Living Organism

When Seedhouse discusses Rational Fields, he offers as explanation the living organism figure of Koestler (1979, quoted in Seedhouse 2002:62-3): a hierarchy of members called 'holon's'. The same figure depicts a stable, integrated structure, a cell, or even an infinite hierarchy of subdivided atoms. The exact ways in which atoms (or neurons) accomplish their functions is not important - only their functional capabilities and the organisation (and interaction) of these. A form of 'social mind' solves complex organizational problems and matters of state, without conscious cognition. This 'social mind' is born of the interaction among all individuals through the rules of institutions that have to date survived cultural selection processes (Smith 2002:553).

4.3.2 Models, Value Judgments and Rational Fields

Models can be also defined as a simplified representation of a more complex reality, i.e. a pictorial model of evolution (adapted from Seedhouse 1997:43-4). The theory represents a more complex situation, to throw light on a problem. Models are a simplification of a far more complex reality; the *Rational Field Theory* (RFT) fits this definition.

These citations are significant, as they indicate the RFT's contribution: 'Centralization of technocratic authority takes over public value judgments' (Graham and Wiener 1995:242); 'Solutions based on expertise and value choices are the likely avenues for improvement' (id.). Seedhouse has developed the health promotion tool - the *Rational Field Theory* (RFT). It enables health promoters to plan and act in honesty, using whatever methods are suited to their quest to create autonomy. RFT shows the structure of the obvious and a plan to put into practice in theoretical clarity (Seedhouse 2002:144). The underlying premise is that we organise the world around ourselves according to numerous conventions, or 'rational fields'. In the context of *societal concerns*, one can hypothesise that these concerns are the consequence of different stakeholders acting according to different rational fields. It is simple and powerful; Seedhouse describes it well. RFT offers the prospect of elucidating beliefs, values and other factors active in decision making, and may provide a novel approach to understanding and dealing with alternative preferences, for getting to the heart of risk management, which is where many of the conflicts over *societal concerns* originate (adapted from Seedhouse 2002, and Ball and Boehmer-Christiansen 2002:26). RFT explicitly recognises that decisions which people and organisations make are functions of instincts and values and classifications, all of which are operative (Ball and Boehmer-Christiansen 2002:31).

Rational fields are interconnected, as none are wholly independent; Koestler's idea (1979, quoted in Seedhouse 2002:64) is that any rational field must have at least one distinct purpose and a strategy by which to pursue it; each part exhibits a goal-directed activity too; goal directed problem–solving activity is the essence of a rational field. The instincts, classifications and values shape the rational field and form its walls (Seedhouse 2002:69). Seedhouse (2002:6) illustrates the template to be used for the RF examples in this thesis.

4.3.3 Evidence and Non –Evidence in the Rational Fields

The 'shadowy pattern of truth' (Seedhouse 2002:143) is complex. The subjective evidence reflects the model we have of the world, the beliefs we have formed about the meanings and predictive value of different kinds of available information, and what information has come to our attention (Simon 1985:30). As evidence is not manifest, Seedhouse (2002:70) illustrates the different phases of evidence, by the 'way in which evidence and non–evidence contribute to formation of rational fields'. Seedhouse specifies seven types of evidence and non–evidence. Only two are evident ('it just is' and 'speculations that can be tested'); the other five are speculations that cannot be tested by reference to the evidence, speculations that cannot in principle be tested by reference to the evidence, filing reality- clarifying the evidence, how we value the evidence and techniques of analysis and persuasion.

5 Conclusion: Literature Review

5.1 What is Lacking in the literature?

The interrelation among the *regulatory framework* for wireless telecommunications, *societal concern*s and risk is the focus of the research. The *Literature Review* showed a gap in the three separated elements, when analysed together. Analysing RF with social science tools needs further research; it seems that researchers have overlooked the work done in parallel disciplines. There is a lack of studies incorporating RF allocation, the societal (including cultural) concerns and risk. The present understanding of the *regulatory framework* for wireless telecommunications is inadequate, as it does not take into account some social perspectives and geopolitical factors. Looking at this as a whole is a new field to be studied.

Cultural Theory and *Rational Field Theory* (RFT) have never been used before with RF regulation - as a means of teasing out drivers and also for identifying roots of *societal concerns*. For the first time research will be carried out to investigate the utility of *Cultural Theory* and RFT in the *regulatory framework* of wireless communications and RF. Tables and figures of these tools are employed to analyse, assess and compare different rationalities and RF risks.

5.2 Particular Research Angle

When assessing risk we encounter in the literature mainly the hazards associated with: health care and promotion, injury control, toxicology, chemicals, biotechnologies; environment aspects (e.g. water and air pollution), natural hazards (e.g. earth quake), climate change (e.g. ozone depletion and global warming); nuclear power plants or nuclear waste repositories, road risks, non-natural radiations (e.g. cellular emissions, power lines and medical X-rays) and insurance. These hazards provide recent and visible examples of risks in which uncertainty plays an important role. The listed hazards are different from RF uncertainties in RF allocation and *spurious emissions*, however despite this, the holistic risk treatment can be similar. The main difference between RF and environment is the irreversibility. Projects impacting on the environment have an irreversible effect (like a damage to an archaeological site or sand dunes by a cellular masts), while RF usage itself is instantaneous and reversible. The RF license may be long but the transmission itself has no long term effect, except the RF hazards. RF *human hazards* may have irreversible effects only in extreme cases of power or exposure. The cellular and power lines *human hazards* are well explored in the literature; however, the comparison of the EMF (and RF *spurious emissions*) national (and regional) levels and the attempt to explain it by culture and geography is original.

5.3 Summary

The *Literature Review* links the *regulatory frameworks*, *societal* and *risk concerns* to the allocation and licensing of resources; it looks at the ways in which other scarce resources and uncertain risks are regulated; the environmental concerns serve as a source to explore the case of RF. Those findings are beneficial to the thesis: the role of nationalism and colonial possession; the classification to four cultural prototypes and the clustering to collectivised and individualised rationalities; the contrast in regulation North versus South and West versus East; the French central-planning 'cathedral' versus the US decentralised ‘bazaar'.

The review of three theories (*Cultural Theory*, *Bounded Rationality* and *Rational Field Theory*) reveals a common denominator: different rationalities. While there has been extensive sociological interest in wireless communications, little research has addressed the problems inherent to the relations of the *regulatory framework*, *societal concerns* and risks. The *Literature Review* contains the relevant points of view on the topic; it explores different ideas and material in the prospective field, to find out what is worth covering in the thesis. It finds that risk and rationality issues need exploring and evaluation. Linking the three sociological theories to wireless regulation and correlating RF allocation to culture and geography may be original.

Chapter 2- *International and Regional Regulatory Frameworks for Wireless Communications*

Contents

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Preamble

The regulation of ‘networked services’ and scarce resources is carried out in various layers, from the top level down, namely Worldwide, Regional, Continental, Intergovernmental, National and State, District, Municipality and 'inside the property' layers. Representatives of the lower layers participate in and influence the regulation of networked services scarce resources in the higher layers. Each level relinquishes some of its sovereignty to gain harmonisation and compatibility; representatives do not insist on certain factors in order to receive support on other more important issues. Each level possesses its own local cultures and thus influences the higher levels. The primacy of higher-level legislation produces both opportunities and constraints for each member. During the period of unification of districts, villages or states, there are common issues to be tackled: which legislation is in force? How should responsibilities and authorities be defined? What role in regulation and standardisation do the lower levels now play? Participation and adoption of regional regulation or standards are derived from a sense of belonging and orientation. In many cases states prefer to claim their sovereignty entirely; they abandon the single market and invent their own wireless rules and standards. This chapter begins at the international level and proceeds downwards to the regional organisations, looking specifically at two cases: Europe (intergovernmental Europe and the supranational European Commission) and South America (intergovernmental South America and the sub-regional international *CAN Comunidad Andina de Naciones*).

1 International Radio *Regulatory Framework*

The Plenipotentiary Conference is the top policy-making body of the ITU (International Telecommunication Union), meeting every four years in order to set the Union's general policies. The ITU is divided into three Sectors: the Radiocommunication Sector (ITU-R) determines the technical characteristics and operational procedures for wireless services, and plays a vital role in the management of the radio-frequency spectrum; the Telecommunication Standardization Sector (ITU-T) develops internationally-agreed technical and operating standards; and the Telecommunication Development Sector (ITU-D) fosters the expansion of telecommunications infrastructure in developing nations throughout the world that make up two-thirds of the ITU’s 191 Member States. The ITU Radio Regulations set a binding international treaty governing the use of the radio spectrum by some 40 different services.

1.1 Geographical Longitude: Three Regions for Radio Allocation

The separation of countries into the three formal ITU RF allocation regions is the source of different RF allocation among continents. The definition of the ITU Regions (capital R, for ITU-R Regions) is based largely on longitude (see Figure 1-1). According to ITU Radio Regulations (RR) section 5.1: Member States assign licences to stations and Article 5 of the ITU RR allocates frequencies to services. The ITU divides the world into five administrative regions: A- the Americas, B- Western Europe, C- Eastern Europe and Northern Asia, D- Africa and E-Asia and Australasia. The ITU also categorises states into three Radio regulatory Regions: Region 1: Europe, Middle East, Africa and the former Soviet Union, including Siberia; Region 2: North and South America and Pacific (East of the International Date Line); Region 3: Asia, Australia and the Pacific Rim (West of the International Date Line). UK and France belong to Region 1, while the US and Ecuador to Region 2. So, at the very least the RF allocations fundamentally differ between America and Europe. Longitude may traverse continents, for example, Meridian E40[1] crosses Europe (Russia), Asia (Middle East) and Africa. The separation may echo the 'Euro-sphere' (including Africa, Middle East and Russia[2]) as Region 1, the American continent as Region 2, and Asia as Region 3. Figure 1-1 which appears in the ITU RR Article5 depicts the ITU Regions and Tropical Zones.

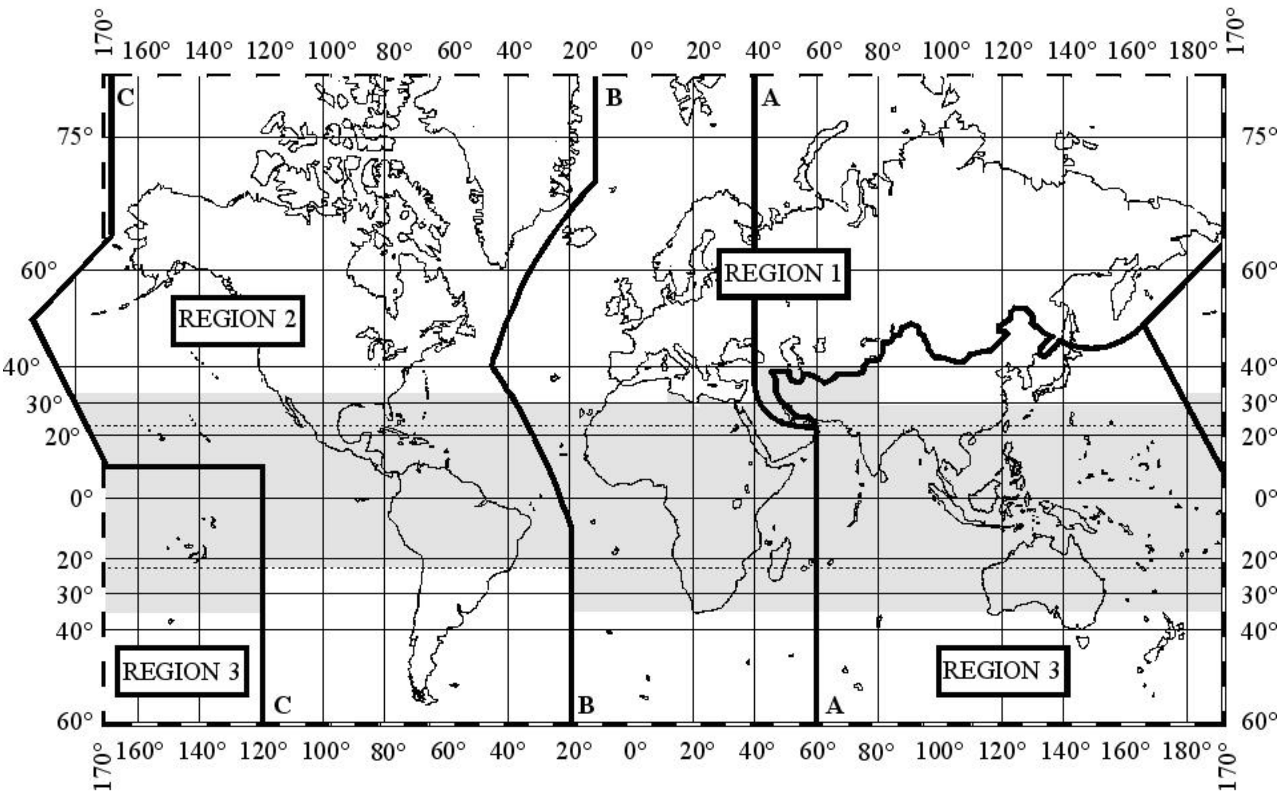

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Figure 1-1 The Three ITU RF Allocation Regions

[1] E40^0 in the figure concurs with the Eastern *Limes* of the Roman Empire.

[2] The roots of Russian culture, legal origin and language are European; part of Russia (West of Ural) is in Europe.

1.2 Geographical Proximity, Latitude, Longitude, Tropics and Wireless Regulation

Geographical proximity facilitates the transmission of broadcasting programs (terrestrial and satellite), the transition of rules and standards. The geographical closeness of Europe to Asia and Africa allows both better marketing from European manufacturers and closer contact by spectrum managers. Subjectively and possibly even subconsciously, regulators tend to hang closer to their neighbours than to those at a distance. Between the Tropic of Cancer[3] (~23° 26' Latitude North) and the Tropic of Capricorn (~23° 26' Latitude South), there are no actual seasons as the sun is never very low in the sky, therefore the climate stays warm and humid ("tropical") year-round. Geography (mainly latitude) influences propagation: forests, seas and tropical zones yield to differences in RF propagation. Shortwave signals suffer from additional atmospheric interference over the Equator. Latitude appears in the ITU Radio Regulations (number 5.16; the shaded part in Figure 1-1 represents the Tropical Zones) in order to reflect the difference in HF propagation[4]; moreover, tropical forests attenuate the RF signals and some regions (such as the Persian Gulf) create 'electromagnetic ducts'. Therefore, tropical latitude may necessitate different wireless technologies or emission powers.

A technical link between latitude and wireless communications can be seen in the quality of Fixed Satellite communications, providing Broadcasting and Fixed services. The Geo Stationary Orbit (GSO) altitude of around 36,000 km provides semi-global Earth surface coverage. However, the latitude of the Ground-Station defines the elevation angle to the satellite and thus limits the edge of coverage. All geo-stationary transponders transmit above the Equator at latitude 0^0; therefore countries with a high absolute latitude value (positive or negative) receive signals with low elevation and much interference from man-made emissions. The practice is to use minimum five to ten degrees elevation of the Earth-Station toward the satellite. The principal limitation in coverage is the area above 75 degrees North or South Latitude (ITU 2002:81-2). The elevation angle to the geostationary satellite equals approximately 90 minus the absolute latitude: in short, the closer the Earth-Station is to the poles, the lower the elevation[5]. In addition in high latitudes, the range of longitudes received by the earth stations decreases. Therefore, the tropical countries favour an improved GSO's coverage: high elevation of receivers (low man-made noise) and increase on the range of potential GSO longitudes.

Figure 1-1 illustrates the fact that North and South America are separated longitudinally.

[3] The sun is directly overhead at noon at the Tropic of Cancer on ~June 21 'solstice', the beginning of summer in the Northern Hemisphere.

[4] Latitude also influences fading of the signal; see ITU-R recommendation P.530 section 2.3.4.

[5] This is the reason that US installed *Minitrack* station to track its satellites in Ecuador in 1957 and not in USA.

From a point of view of coverage from the GSO, South America and most of Europe and Africa may be connected through one satellite; North America may be connected partially with the Far East/Australia through one satellite over the Pacific; and one GSO can cover North America and Western South America (up to certain latitudes). The GSO broadcasting signal is well received only if the receivers employ the same standard across the continents. This feature may explain why the East part of South America operates the same TV standard (PAL) as Europe, and the West part of South America operates the same TV standard (NTSC) as North America; see Figure 3-4 p. 95. Moreover, geographical proximity obligates harmonisation of the RF satellite bands, in order to avoid harmful interference. Longitudinal separation assists in the coordination challenge, as there is less potential interference and more places for additional satellites. The American GSO services have benefited this coordination; unfortunately Europe, Africa and Asia have no such benefits. It is easier to coordinate GSO satellite systems covering North America with those covering South America than it would be if these two continents were lying in the same longitude.

1.3 International Allocation and Licensing Process

The ITU Radio Regulations (RR18-1§1,1) state that 'No transmitting station may be established or operated… without a licence issued… by or on behalf of the government of the country to which the station in question is subject'. The RF assignments of licenses follow the national RF allocation table, and national regulators follow their ITU Regional allocations in the Radio Regulations. Therefore, it is essential for UK, France, the US and Ecuador that the ITU-R will regulate the RF bands in alignment with their wireless communications (and vice versa). The most active players in the ITU-R are the US, Japan, France, the UK, Russia[6] and Germany; China is a newcomer to ITU-R meetings. In addition to frequency allocations, the ITU-R develops Recommendations to facilitate shared operation of the RF spectrum. For example, ITU-R has developed the next generation cellular system IMT (International Mobile Telecommunications) 2000, through the use of Recommendation M.1457, which recommends the terrestrial interfaces of third generation (3G) standards; the ITU-R did not succeed in regulating one harmonised worldwide 3G telecommunication system, nor one global digital TV standard. ITU-R recommendations are important; for example, France (despite the technology-neutrality) and *CAN* (resolution CAATEL-XIII-EX-58) impose IMT 2000 in cellular licences. ITU-R also carries out worldwide coordination of systems operations; examples of this are satellite-based systems and HF communications.

[6] The ITU-R director is Russian; Russia leads the RCC (Regional Commonwealth in the Field of Communications) 12 countries- created in December 1991.

1.4 Worldwide Regulation and Standardisation

The RF allocation cannot be totally deregulated, as harmful interference will restrict the successful operation of RF systems, including those ensuring safety of life[7]. Regulation and standards are the two mainstays of the *regulatory framework*. In Europe these tasks are divided between two bodies: CEPT (*Conférence Européenne des Administrations des Postes et des Télécommunications*) performs the regulatory tasks; while ETSI (European Telecommunications Standards Institute) is the main standardisation organisation. The US FCC (Federal Communications Commission) mainly takes a regulatory stance and implements standardisation functions. The global bodies, ISO (International Organisation for Standardisation), IEC (International Electrotechnical Commission), CISPR (International Special Committee on Radio Interference) and IEEE (Institute of Electrical and Electronic Engineers)[8] influence the US more than Europe, as the FCC relies on these standards more than those of the EU[9] and other European countries. At a global level, the ITU-R develops regulations and is managed mainly by national administrations; the ITU-T prepares telecommunications standards and is maintained by the industry. Similarly, CEPT (48 countries) is governed by Member States, while manufacturers administer ETSI. Standards are designed by an official body to promote compatibility and interoperability (Sarvas and Soininen 2002:2). In Europe and the USA, standards are open and easily accessible to all. In wireless technology, where global functionality like worldwide roaming is essential, the international compatibility of standards plays a key role.

1.5 Globalisation of RF Regulation

Communications (like computers; see Cooke, Moulaert, Swingedow, Weinstein and Wells 1992:7) systems operate on a global scale. By consensus, the ITU has imposed RF regulation since the first days of radio transmission. As RF is considered a technical item, 'rational' administrations may not seek the separation of their national RF plans in isolation from their regional and worldwide activities. In the 20th century, manufacturers pressed for regional standards on the basis that a regional, rather than global, market was sufficient for economies of scale; in the 21st century, when communications equipment and low-cost Licence Exempt systems (such as Wi-Fi, the typical example of bottom-up success, in contrast with the top-down GSM success) can move easily across borders, global regulatory harmonisation is essential. At the beginning of the 1990s, these were the European fragmented Cellular

7 Some Mobile (land, maritime and aeronautical) communications are defined as safety of life systems. The Police, ambulances/paramedics and Fire Brigade use wireless communications intensively.

8 The professional association of more than 365,000 individual members in approximately 150 countries; IEEE develops standards such as 802.11 Wi-Fi, and limits of Human Exposures (C95.1-2005).

9 'European Union' established by the Treaty of Maastricht; interchanged sometimes (including in this

standards: NMT, British TACS, German C-Netz, Italian RTMS, French RC-2000 and MATS-E (Bekkers and Smits 1999:31,156). In the 21st century, the evolved European GSM (to UMTS also termed 3GSM) and the evolved American CDMA TIA-95 (to CDMA2000) are developed by groupings of international standards bodies, operators and vendors 3GPP[10]1 (for UMTS) and 3GPP2 (for CDMA2000). Countries wishing to join regional and global organisations accept the rules and procedures of these institutions, thereby in effect conceding some of their sovereignty. This may be illustrated by the fact that European countries are governed by measures taken by the EU, and other European telecommunications regulators are bound at the international level by ITU and World Trade Organisation (WTO). Since international measures are part of community law (the Commentary of Rogers in Lofstedt and Vogel 2001:414), EU telecommunications experts also need to be informed about international measures. Within the framework of ITU and WTO, the US influences and follows global regulation and RF worldwide allocation. There is globalisation in new wireless allocations; for example, all RF allocations above 42 GHz are similar in all ITU Regions. In today's digital era there is a convergence toward less wireless standards in cellular and digital TV, since a fragmented market is bad for suppliers, operators and consumers.

WTO implemented the challenge for ‘specialized supranational regulatory institutions’ (Hall, Scott, Hood 2000:210-1), through the agreement of 69 countries to a policy of telecommunications liberalisation in 1997. The WTO Reference Paper for Telecommunications of 24 April 1996 contributed to the liberalisation policies. GATS (General Agreement on Trade in Services - of WTO) and TBT (Technical Barriers to Trade Agreement) rules, as well as regional laws (such as EU Directives) serve to reduce differences in regulation. OECD (Organisation for Economic Co-operation and Development), IMO (International Maritime Organisation), ICAO (International Civil Aviation Organisation) and Global Symposiums for Regulators' activities accelerate common regulation and harmonised standards in the telecommunications sector.

The Information Society (such as the Internet) shortens distances and leads to closer regulation. As a result of globalisation, the EU and US standards converge; for example, it is necessary to have a universal Wi-Fi in the computer industry in order to permit worldwide roaming. There is a strong desire around the world to standardise, integrate and harmonise license-exempt devices, such as Bluetooth. The standards of Short Range Devices (SRD) are ubiquitous and worldwide, as it is difficult to restrict them through frontiers and other

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research) with European Community and EC (European Commission).

[10] 3rd Generation Partnership Project, a worldwide collaboration agreement.

barriers. The globalisation, worldwide suppliers, global roaming and free circulation of SRD enforce the same technologies around the world. However, there is still no globalisation of the RFID (RF IDentification); the failure to harmonise a global RF band in 860-960 MHz disables RFID operation across Regions.

The Finnish Nokia and the American Motorola, the two largest cellular manufacturers, are influential players in both the US and Europe, respectively; their activity encourages worldwide standards. During the policymaking process of digital TV, the manufacturers Thomson and Philips have been participating in both the US and European markets; they were instrumental in blocking the international adoption of Japanese Hi-Vision standard in Dubrovnik in 1986; they supported the European HD-MAC (High Definition-Multiplexed Analogue Components) system; they were also a part of a Grand Alliance consortium in the US (Dupagne and Seel 1998:305). Global operators and suppliers are influential in exporting the consumer cultures of the developed countries (the US in particular) to the developing or underdeveloped countries (Herman and McChesney 1997 and Schiller 1998).

2 RF Regulatory Framework in Europe

2.1 RF Regulation in the European Continent

2.1.1 The Intergovernmental and International Regulatory Relationships

This section studies the European *regulatory framework*; it explains what is regulated by agreements made in CEPT and by the EU Directives. CEPT represents the international cooperation process between European countries on a single policy for Postal and electronic-Communications. There is a difference between the EU and all the other countries in Europe. EU represents the countries who have agreed to develop common policies in certain fields; an EU integration process covers a fairly small number of countries (27 in total). Within the EU group of countries, a process of integration of e-Communications policy in general and RF regulations in particular has taken place.

Figure 2-1 depicts the key players, indicating where countries and organisations overlap.

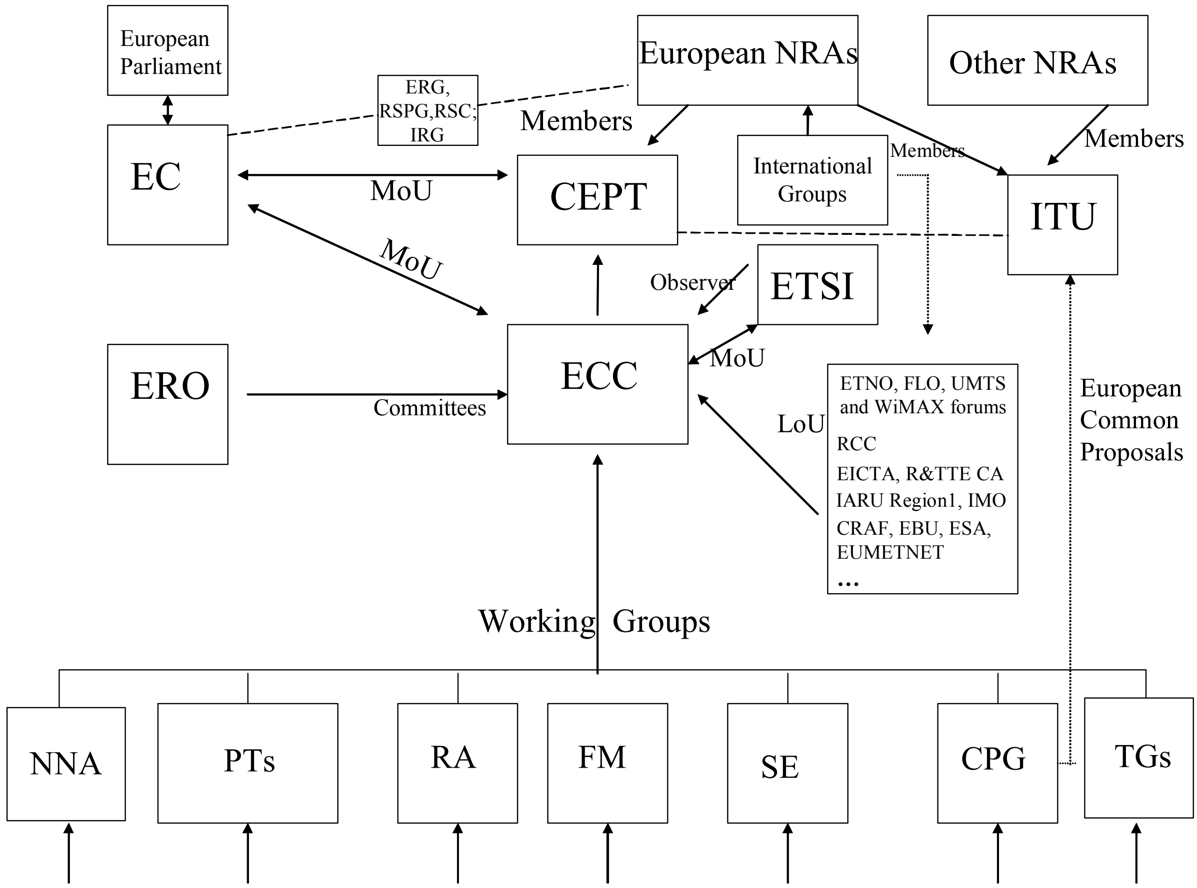

Figure 2-1 The Main Players in European RF regulation[11],[12]

Key: CPG: Conference Preparatory Group (preparations for ITU Conferences); CRAF: Committee on Radio Astronomy Frequencies; EBU: European Broadcasting Union; EC: European Commission; ECC: Electronic Communications Committee (formerly European Radiocommunications Committee ERC); EICTA: European Information and Communications Technology Industry Association; ERG: European Regulators Group (EC body); ERO: European Radiocommunications Office; ESA: European Space Agency; ESOA: European Satellite Operators Association; ETNO: European Telecommunications Network Operators; EUMETNET: European National Meteorological Services; FLO Forward Link Only; FM: Frequency Management; IARU: International Amateur Radio Union; IMO International Maritime Organisation; IRG: Independent Regulators Group (pan-European body); NRA: National Regulatory Authority; NNA: Numbering, Naming and Addressing (non RF); Project Teams PT PT_1: IMT2000, PT_2: TRIS Technical Regulation and Interconnection Standards, PT_9: Maritime issues; Task Groups TG: UWB (TG3) and Digital Dividend (TG4). RA: Radio Affairs (Radio and e-Communications); RRC: Regional Commonwealth in Communications; R&TTE CA: The Radio and Telecommunications Terminal Equipment Compliance Association; RSPG: Radio Spectrum Policy Group (EC body); RSC: Radio Spectrum Committee (EC body); SE: Spectrum Engineering. Industry Stakeholders, namely companies, consultants, industry groups and international agencies, contribute to the ECC Working Groups.

11 Note: Solid arrows represent stronger influence; dashed arrows represent weaker influence.

12 This chart was inspired by two sources: Cave 2002:210 and *Frequency Management and Standardisation in Europe* 4-6 March 02-ERO. The figure was updated on 7 Dec.07, following the comments of Mr. Yurdal.

2.1.2 The Main International European Organisations

CEPT

In conjunction with the European policy of separating postal and e-Communications operations from policy-making and regulatory functions, CEPT became a body of policy-makers and regulators itself. Its original members were the incumbent monopoly-holding postal and e-Communications administrations. CEPT was set up to advance European cooperation on commercial, operational, regulatory and technical standardisation issues. CEPT promotes European harmonisation, inter alia of the radio spectrum, with an emphasis on practical cooperation between European countries to help realise Europe-wide regulatory harmonisation. With its 48 members, CEPT now covers almost the entire geographical area of Europe. CEPT carries out its activities at a pan-European level. The committees handle harmonisation activities within their respective fields of responsibility, and adopt recommendations and decisions. These recommendations and decisions are normally prepared by their working groups and project teams. CEPT merges the e-Communications wire and wireless activities. ERO[13] supports the activities of the committee and conducts studies on its behalf and also for the EC (with its RF experts who are able to assist the EC if necessary). For example, the EC mandates CEPT to perform technical activities, such as to harmonise the frequency usage for SRD. International coordination is arranged by CEPT through ECC. CEPT broadens Europe's influence in e-Communications by signing Memoranda of Understanding (MoU) and Letters of Understanding (LoU) with other international organisations[14].

It should be emphasised that CEPT has no legislative basis (unlike the EC) and works largely by consensus. Its Recommendations and Decisions are not mandatory; this is one of the perceived CEPT weaknesses from the EC perspective. National Regulatory Authorities are encouraged to implement these recommendations and to notify the Chairman of ECC and the ERO of how they are implemented at the national level. This has proved to be an effective tool for harmonisation. In fact, in 1982 CEPT formed *Groupe Spéciale Mobile* GSM to design a pan-European mobile technology; the GSM is one of its most important achievements. CEPT also brought about the foundation of ETSI in 1988.

[13] As a response to the convergence in the telecoms sector, the two committees dealing separately with radio and telecoms, ERC and ECTRA, have been replaced by the new ECC. Also, the former ETO (European Telecommunications Office) and ERO have been merged into one body, to be named in the future ECO.

[14] http://www.ero.dk/1340AB0F-0062-40A3-BDD4-0BA1BAC35584.W5Doc?frames=no 7/12/07.

ETSI

ETSI was awarded full authority from CEPT to develop standards; ETSI is mandated (contracted) to support the European regulation and legislation. ETSI is an independent, non-profit organization, whose mission is to produce Information and Communication Technologies (ICT) standards within Europe. ETSI unites 696 members from 62 countries[15] both within and outside Europe, including manufacturers, network operators, administrations, service providers, research bodies and users. ETSI brings together key players in the ICT arena. Together these experts (including Administrations) work for ETSI in over 200 groups. ETSI deliverables include Harmonised European Norms (HEN or EN), Technical Reports (TR) and Technical Specifications (TS). The ENs are approved by 37 National Standards Organisations (NSO). Like CEPT rules, ETSI's standards are built primarily on consensus, and the standards are used on a voluntary basis in Europe and in other regions. However, the CEPT member countries have an obligation to use the ETSI EN[16]; the ETSI standards (and R&TTE 'CE' marking) are accepted also in Russia.

ETSI's most frequently applied technical standards lie in the area of mobile cellular (GSM and UMTS) and digital TV (e.g. DVB-T). ETSI develops the Radio and Electromagnetic Compatibility (EMC) standards for the R&TTE (Radio equipment and Telecommunications Terminal Equipment) Directive. The two other recognised European Standardisation Organisations are CEN (with a few EMC standards) and CENELEC[17] (safety standards, including RF hazards and EMC standards). Europe has adopted EN 300 744 V1.5.1, the ETSI standard for Digital Video Broadcasting; EN 300 910 V8.5.1 (2000-11) is the original GSM standard, and EN 300 392 is the TETRA standard.

As ETSI standardises the harmonised European telecommunications, most of the National Standards Organisations' (NSOs) traditional functions are superfluous. The French '*Association Française de Normalisation*' (AFNOR) is an example of an NSO whose national and international influence has decreased.

EFTA

The European Free Trade Association (EFTA) is an international organisation comprising Iceland, Liechtenstein, Norway and Switzerland. The aim of EFTA is to promote free trade and economic integration. The Association participates in the European Economic Area (EEA) and maintains its free trade agreements. The success of the EC has limited EFTA's reach to the western European countries which did not join the EU, and EFTA has thus

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15 http://portal.etsi.org/docbox/Seminar/Powerpoint%202007/Sem02-16.ppt#338,2,ETSI 9/12/07.

16 see ETSI Rules of Procedures Article 13, http://www.etsi.org/directives/Directives.htm#RoP 7/12/07.

17 *Comité Européen de Normalisation Electrotechnique*; European Committee for Electrotechnical Standardization.

become one of their interfaces to the EC. EFTA officially implements the EU R&TTE Directive and practically all EU radio regulations.

2.1.3 Europe- RF Regulatory Framework: Overall Approach

European administrations and ETSI are active in developing RF regulations and standards: ECC develops the regulation, while ETSI is responsible for the standards. The CEPT rules and ETSI standards are less obligatory than EU Regulations and Directives, unless appearing as a recommendation or standard in the EU deliverables. Administrations, manufacturers and service providers meet frequently to prepare the rules that are implemented as binding regulation all over Europe. Harmonisation of RF allocations and free circulation are endorsed by European harmonised standards and regulation. Higher population density within Europe necessitates international RF coordination. The *regulatory framework* of Europe is dynamic: organisational changes are taking place (for instance, the convergence of the wireline phones and radio communications into the new ECC), and intensive activities in working groups and project teams are intended to harmonise the European RF spectrum and produce one European view toward the ITU and other non-European organisations.

European countries participate in the harmonisation process, and then adapt their national allocation to the common European ones. Two columns have been added to the Harmonised European Allocation table (ERC Report 25 2007), where national utilisation and national notes are recorded. Thus, their national allocation table is harmonised with their Region.

Traditionally, the European broadcasting services were either organised as national services by administrative agencies of the Government, or if operated by private companies, still remained under the provision and control of the Government (Codding 1952:113); broadcasting was centralised in a public institution with a monopoly; it was usually run under a semi-independent board appointed by the government or the national legislature (Noam 1992:3, quoted in Hart 2004:32).

Much of the progress achieved in Europe was governed by the EU (27 countries), CEPT (48 European countries) and the ITU (191 countries). EU Directives have a direct impact on European telecommunications domestic activities. The global RF allocation is prepared by the ITU, while the European allocation and regulations are developed by CEPT. Regarding sovereignty, RF and telecommunications regulation is more technical (and less nationalised) 'ether', not associated directly with national aspects, which created borders and the break-up of Europe. It is much easier to harmonise RF spectrum in Europe than to harmonise territory, defence, foreign policy, education, health, language, religion, legal system, currency, social assurance or taxes. European Administrations are actually responsible for the regulation of RF in their respective territories, such as specific radio channel assignments and licences, national legislation and monitoring, as well as contributing to the regulation at a European level, in the various super-national and international organisations. RF allocation and allotment in Europe is hierarchic: top-down, above the national level. The main radio regulation and allocation is formed on a European level (for example, the GSM allocation in the 900 MHz RF band). European countries actually relinquish their prerogative rights in favour of European harmonisation; they acquire their regulatory uniformity through the European hierarchy. The real necessity to harmonise RF spectrum and the desire for a single market (that is, a pan-European market for the economies of scale) motivated them to adopt a common regulation. The UK and France's *regulatory frameworks* are typical of developed countries' regulation in Europe. In practice France, Germany and UK lead the European RF regulation via professional European frameworks; see the next chapter, *Case Studies*.

The commonality in RF allocation in Europe is becoming standard as a result of the 2002 Framework Directive 2002/21/EC. One of the most visible institutional changes of the Framework Directive is the establishment of the independent regulator that is separate from interested parties, in order to ensure fair competition in the marketplace. The superior (higher level) Ministry is more concerned with development issues and with the broad policy concerns and politics of the national government. The assertive promotion of top-down regulation overcomes national 'conservative' powers. In RF, Europe does unite ('united in its diversity'[18]), despite the disparity in European cultures: namely language, religion and legal origin. The study of the European RF regulation shows a pattern shift from the concept of a "small village world" in every European country, into a "federal" structure (Heclo and Wildavsky 1974, quoted in Hall, Scott and Hood 2000:34-5). Policy-makers in Europe promote harmonisation; they possess a broader view, higher than technology, law and economy. Policy-makers have successfully forced the adoption of GSM technology in the 1980s: Council Recommendation 87/371/EEC imposing the GSM. RF harmonisation is placed ahead of other issues in the order of European priorities. Outside Europe, the CEPT wireless regulation influences all of ITU Region 1 (African countries and Middle East), East Asia (India and New Zealand) and Latin America. Europe is successful for a wireless common market. The RF harmonisation illuminates the commonality among the European countries, as opposed to nationality and borders. As the RF in Europe is regulated through the supranational EU and intergovernmental CEPT frameworks, and standardisation is carried out by ETSI, the role of the national regulators and national standards organisations is reduced.

[18] The phrase was deliberately highlighted in quotation marks in the text of the draft European constitution.

Geographical Longitude Influencing Wireless Rules in Europe

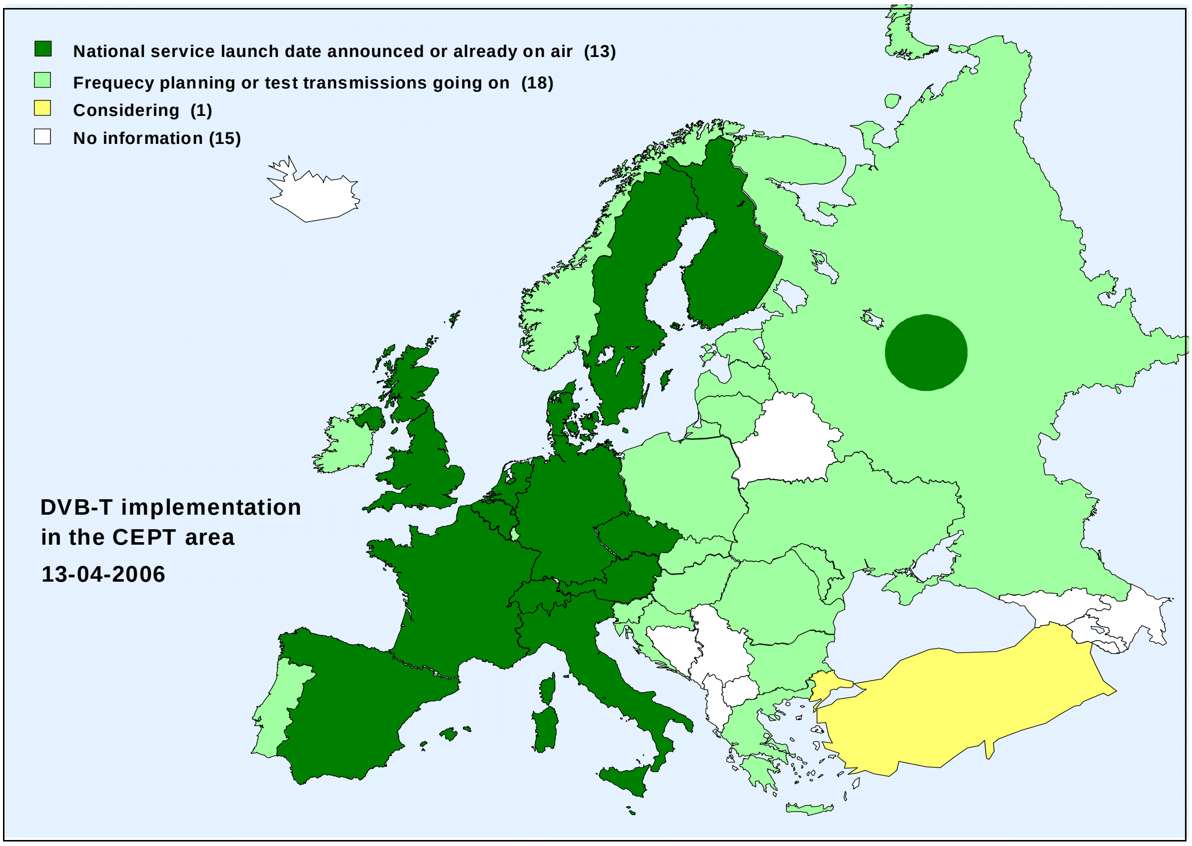

Figure 2-2 DVB-T adoption in Europe[19]

Figure 2-2 indicates that geographical location influences the wireless development; longitude is significant in this. Western Europe is more advanced than Eastern Europe in adopting new technologies, in this case, digital TV. The cellular penetration depicts a similar pattern. A country's longitude obviously affects its proximity to Western Europe. Eastern Europe is economically less developed than the west; based on the *Indicators' master-data* (49 European countries that provided data), in 2004, the average cellular penetration in the East may be seen to be significantly lower: 27% versus 70%. Moreover, religion changes with longitude; Eastern Europe is mainly Eastern Orthodox and Western Europe is Catholic and Protestant. In Western Europe, the northern countries are more observant of Protestantism than the southern countries (being more Catholic); northern Europe adopted Protestantism, namely Iceland, Finland, Sweden, Norway and Denmark. It is interesting to mention that in Germany and the Netherlands the southern part of these countries is more Catholic than the north. Practicing the same religion (and the distance from Western Europe) advances the connections with Western Europe; e.g. the relations of Europe with Catholic Poland versus Islamic Turkey; Poland is a member of the EU, while Turkey is not. The influence of the Soviet Union before (and after) 1992 is also related to the geographical location of that country, and the dominance of Russia over all that surrounds it.

Geographical Latitude and Cellular Penetration

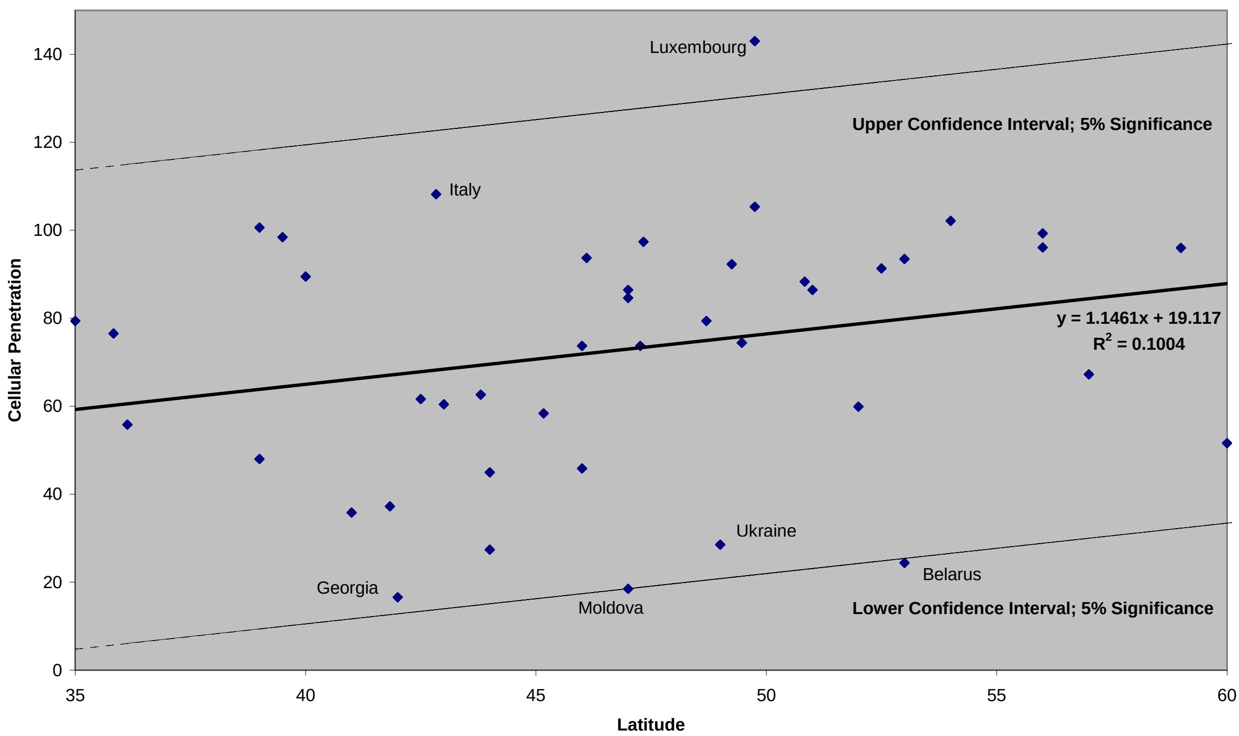

Figure 2-3 Cellular penetration versus Latitude in Europe

Figure 2-3, retrieved from the *master-data*[20], shows that cellular penetration in Europe increases with Latitude (y = 1.1461x + 19.117 and R^2 = 0.10). The confidence intervals indicate the outlined countries relative to Latitude: Luxemburg and Italy are above the expected value plus two standard deviations; whereas the ex-USSR countries Georgia, Moldova, Ukraine and Belarus are below the confidence interval.

Geographical Latitude and TV Reception

The European Commission[21] compared the television reception in 15 countries via 'Cable', 'Terrestrial' and 'Satellite'. The results of the study indicate the influence of latitude on television reception: 46% of the households in the EU countries receive television services only by standard terrestrial broadcast. Greece tops the other countries with a penetration rate of 94%. At 83%, Spain comes in the second place, followed by Italy (78%), France and Portugal (both 65%). As far as television reception via cable only is concerned, the penetration rate stands at 32% of the households. The highest percentage for cable penetration goes to Belgium with 90% of the households. There are major differences in the penetration of satellite television alone - 19% of the households receive only satellite television. Germany has the highest penetration rate, at 38%. Relative to the northern countries, southern Europe shows a marked preference for terrestrial television only. This

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[19] http://www.ero.dk/8ABFBDDA-2D38-4E42-9285-1E70C06A78B8?frames=no 27/02/08.

[20] Based on the ITU-D World Telecom Indicators 9th edition, Dec. 2005; updated to 2004, per 100 inhabitants.

can be related to national culture. In the south, citizens expect to receive a TV signal also when outside their house, for example when camping or at the seashore. The 'Satellite Only' TV reception is maximised in the central latitudes. This might create a balance between the more developed north (but where the Broadcasting Geostationary Satellites are emitting at lower elevation and received worth than in the south; see section 1.2), and southern Europe (which prefers the old terrestrial TV reception).

Scandinavia and Mobile Communications

'Northern Europe is the continent of the cell phone' (Burgess 2004:32). While cellular technology started as mobile services (i.e. in vehicles), now it is mainly handheld. The high penetration of the cellular in Nordic countries (they are leading the world in cellular supply, pioneering and penetration) may be explained also by geography and climate. The mobile telecommunications are crucial during winter storms, while driving between cities and to isolated places. We may notice also the importance of communications for fishermen sailing far out from the coastline[22]. A low population density is characteristic of Nordic countries; the wireless infrastructure ensures access to communications for the sparse rural population. This dependence on mobile communications could become the basis for the future cellular industry and penetration rate. Satellite Communications could provide a similar solution for isolated locations; however, Nordic countries located at high latitudes receive poor signals from fixed satellites (and small range of longitudes). The Nordic Mobile Telephone (NMT) cellular enabled roaming in all of the Nordic states from its launch (Burgess 2004:34, citing Muller and Toker 1994:191). The NMT (since 1981) 'put the sharpest edge of development of handheld phones and network infrastructure to Nordic companies like Nokia[23] and Ericsson; that edge was carried over to digital GSM world'[24]. The Swedish "NMT-expert" (Östen Mäkitalo) assisted in the development of the first ever cellular system. Japan invented their cellular in 1957 and developed it only for internal use; unlike Japan, small countries like Finland should direct their equipment to export and international interoperability. Moreover, in Scandinavia (and the whole of Europe), vendors are leading the standards toward a single harmonised market; whereas in Japan, the operator NTT DoCoMo is leading the standardisation, emphasizing the Japanese market, as has been the case in the past.

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21 Data and charts are from *EC Telecoms Services Indicators* Sept. 04; about the first 15 EU member countries.

22 Indeed, the Norwegians have their own satellite constellation, called Thor. They are also heavy users of the International Maritime Satellite service (Inmarsat) in their fishing fleets in the North Sea and north Atlantic.

23 In third quarter 07 the Finnish Nokia ships more mobile phones than next three vendors combined; Nokia's handset market share closes on 40% http://eetimes.eu/scandinavia/202602813; 9/1/08. For the fourth quarter 07, the Swedish Ericsson registered a wireless equipment (mainly base stations) market share of 34%. http://www.telecomtiger.com/fullstory.aspx?storyid=858&flag=1&passfrom=topstory; 9/11/08.

24 E-correspondence with Ari Lahtinen, an expert from Finland, 5 July 05, and Pasi Toivonen, head of mobile division at FICORA, 2 Aug. 05.

Unlike most of the other European countries, there has been never a state telephone monopoly in Scandinavia (Bekkers and Smits 1999:28); this fact is indirectly related to latitude; it reveals a market-based rationality, typical of the Nordic countries. In February 1987, eight different cellular systems were tested in a European competition held in Paris. A GSM system developed by the researchers Maseng and Trandem at the Norwegian University of Science and Technology won and was chosen; the first GSM specification was completed. Commercial GSM operation began in 1991 with Radiolinja in Finland. The Finnish operator Elisa was the first to test UMTS on the GSM 900 MHz infrastructure.

European Indicators

All European countries belong to ITU Region 1, all are non-tropical, and all countries are Christian, except for three Muslim countries Albania, Bosnia and Herzegovina, and Turkey. All use 50 Hz mains electricity power. Europe applies the PAL and SECAM analogue colour TV; no NTSC standard in any European country. In the 1980s Europe operated VHF TV systems A, B, B1, C, D, D1, E I and L, and UHF TV systems G, H, I, K, L. The same analogue TV standard acknowledges proximity; for example, Lithuania, Latvia and Poland operated TV system D. The analogue colour TV systems preserve the roots of the UK, German and French standards and rules, now unified under ETSI standards and the EU *regulatory framework*. All Europe operates (or will soon operate) the single DVB-T; an agreement was made in November 2005 between EU ministers in charge of telecommunications to end over-the-air analogue TV before 2012 (and to implement the digital TV standard). European countries utilise GSM, 27 countries operate the UMTS, and 35 employ the TETRA system. Europe follows in general ICNIRP RF Exposure limits for *human hazards*. More specific data is given in the Appendix B: *Master-Data*.

European Regulation: Conclusion

CEPT is the communications regulator of Europe; however, it does not possess the same legal supremacy as EU. CEPT member countries outside the EU follow a different *regulatory framework*; nevertheless, over time, the EU RF regulation gradually creates a harmonised European regulation. Europe influences other continents through culture, market, wireless regulation and standards. A growing number of Central Eastern European Countries and Baltic countries have fully liberalised their e-Communications sectors and implemented the EU *regulatory framework*[25]. Countries like Switzerland[26] and Norway, that are also not members of the EU (but part of CEPT), follow the EU RF harmonisation and

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[25] Ursula Lochmann, Detecon Int *ITU-T Workshop on Convergent Regulation: Is it becoming Technology-Neutral?* Geneva, 17 May 2004.

[26] 'Switzerland is indeed not part of the EU but nevertheless we try to comply with their regulation. Our new regulation follows therefore mostly the EU-directives…' RM@bakom.admin.ch 24 May 04.

Directives (at least the R&TTE). This is proof for countries outside EU (and Europe) that EU regulation may be followed; it provides evidence that non-EU and non-European countries may adopt similar EU Directives. Geography (the latitude and longitude of the country) influences the implementation of digital TV and the penetration of cellular and satellite TV.

2.2 Supranational Europe: the European Union

2.2.1 EU Deliverables

The activity of EU, where policymaking is needed, encompasses among others, the EC Directorates General (Hood 1999:166). The e-Communications' EU Directives are examples of intergovernmental constraints. The underlying objective of the EU regulation has been to promote an open and competitive market in telecom services throughout the EU. When the EC decided to liberalise the telecom industry in Europe, due to the social and economic benefits that would result from such a liberalisation, a series of policy documents and EC Directives were developed. Radio spectrum regulation is governed by the EC Directives 'to establish an arena for all users of radio spectrum, which is based on open, objective, non-discriminatory, and transparent grounds'[27]. The EC treaty explicitly authorises the European Community institutions to adopt five different types of legal 'measures'. The most important European regulations concerning RF are (see Gilles and Marshall 1997:570-1):

1) Regulations: legislative rules of general application; that is, not addressed to any particular Member State, individual or entity. They constitute binding law and create legal rights and obligations for Member States and private parties. Unlike Directives, 'Regulations' require no implementing action by Member States; for example, *Council Regulation (EC) No 1/2003*, authorising the 'block exemptions'[28].

2) Directives: binding instructions (article 249 EC- Treaty) to all the Member States to ensure that their laws, regulations and administrative decisions conform to the pattern laid down in the Directive. For example EC Parliament and Council Directives of 7 March 2002,

– 2002/20/EC *on the authorisation of electronic communications networks and services (Authorisation Directive);*

– 2002/21/EC *on a common regulatory framework for electronic communications networks and services (Framework Directive).*

3) Decisions resolve particular cases involving named parties. These decisions are legally binding. For instance:

–Decision No 676/2002/EC of the European Parliament and of the Council of 7 March

[27] EC Green Paper 1998 on Radio Spectrum Policy; p. 25; repeated in the' Regulatory Framework' 2002, Article 9 EC Decision No 676/2002/EC of the European Parliament and of the Council.

[28] Agreements falling under 'block exemptions' do not need to be notified to the Commission.

2002: *on a regulatory framework for radio spectrum policy in the European Community (Radio Spectrum Decision).*

— Decision C(2005) 2467 *on the harmonised use of the 5 GHz frequency bands for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs).*

4) Recommendations: from the Council and the Commission which suggest courses of action to the Member States. Recommendations impose no legal obligation on Member States or individual parties. An example of this is EC Council Recommendation 1999/519 of 12 July 1999 *on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz).*

5) Several other kinds of non-binding measures, such as Council or Parliament 'Resolutions', 'Council Conclusions' and EC papers like:

— Green Papers, discussion papers published by the Commission on a specific policy area. In some cases they provide an impetus for subsequent legislation. For example, the EC Green Paper COM(98) 596 of 9 December 1998 *on Radio Spectrum Policy*.

— White Papers, documents containing proposals for Community action in a specific area. White papers contain an official set of proposals in specific policy areas and are used as vehicles for their development. For instance, the White Paper COM(2003)673 of 11November 2003 *Space: A new European frontier for an expanding Union- An action plan for implementing the European Space policy*.

The R&TTE Directive[29]

The R&TTE deserves a more detailed look, as it illustrates the European regulation. The Directive covers most equipment that uses the radio spectrum and all equipment connected to public e-Communications networks. This market includes, amongst others, GSM and UMTS handsets, normal telephones and data transmission modems. It simplifies the technical requirements and assists manufacturers in market access by permitting them to carry out self-testing of their equipment for conformity. All products must comply with the R&TTE conditions. The Directive produces one European market 'equipment which complies with the relevant essential requirements[30] should be permitted to **circulate freely**; whereas the putting into service may be subject to authorisations on the use of the radio spectrum' *("Whereas 32" in the Directive*). There are two classes of equipment. Type 1

[29] EC Directive 1999/5/EC 7 April 1999, *on Radio equipment and Telecommunications Terminal Equipment and the mutual recognition of their conformity*.

[30] 'Health and the safety requirements contained in Directive 73/23/EEC; protection requirements with respect to EMC contained in Directive 89/336/EEC; in the case of radio equipment, to use the spectrum allocated to terrestrial/space radio com and orbital resources so as to avoid harmful interference'.

needs a declaration only, as it is EU harmonised; any radio that is compliant with a harmonised standard (such as GSM and DECT) can be placed on the EU market directly without any permission or notification to the radio authorities. Type 2 is special equipment and needs extensive type approval. The R&TTE provides more flexibility to manufacturers; but at the same time more responsibility, in case of violations. Article 12 of the Directive specifies the 'CE- marking'[31]: this marking guarantees that the equipment complies with the requirements of the R&TTE. The Directive is implemented in 31 countries of EU and EFTA; 'CE' is accepted in countries outside Europe: Singapore and Taiwan accept it; Israel and Ecuador (see *case study*) refer to the 'CE' in some applications.

2.2.2 EU Overall Approach

Central powers can lead to a flourishing and cosmopolitan culture; the cases of the Roman and British Empires, France under the Bourbons and Austria-Hungary under the Habsburgs might support such a contention. Majone in Baldwin, Scott and Hood (1998:203) explains the growth of EC regulation by the tightness and rigidity of the Community budget; the desire of the Commission to increase its influence by expending its competencies, and the preference of multinational firms for dealing with a uniform set of rules rather than with different national regulations. The transfer of regulatory power to an intergovernmental authority like the EC makes more stringent regulation credible, and improves the behaviour of regulated firms (Baldwin, Scott and Hood 1998:205). The Commission has consistently taken a stricter pro-competition stance than national authorities, namely pressing for adoption of the GSM as a pan-European standard. Moreover, debates in the Commission follow substantive rather than national lines (Baldwin, Scott and Hood 1998:207). The core of the 'Eurocratic Regulation' and regulatory activity is the setting, monitoring and enforcing of rules and standards; EU regulation tends to enhance and formalise regulation inside government at a national-government level (Hood *et al*. 1999:162,184,199). Issues can be taken out of the bureaucratic and into intergovernmental- inter-institutional bargaining arena far more easily in the EU than they can be moved out of the national bureaucratic arena in most Member States.

The EU telecommunications markets were liberalised in 1998: all markets were opened and competition was supported by the creation of an independent regulatory authority in each country; there are now restrictions only in case of scarcity of resources. Liberalisation was introduced through a new regulatory approach. Free circulation of goods and equipment is a

31 "CE" is the abbreviation of "*Conformité Européene*" which literally means "European Conformity". The term "CE Marking" appears in the Directive 93/68/EEC in 1993.

basic EU policy. Liberalisation and re-regulation are strongly driven by EC. Harmonisation prevents unnecessary discrepancies between regulations of Member States (EU-specific); the coherent regulation supports an e-Europe Action plan to develop an information society. EU promotes minimal regulation; only imposing *ex-ante* (prior) regulation where competition is not effective and where competition law is not sufficient. It rolls back regulation where it is no longer needed. This 'light touch' licensing approach simplifies market entry. However, the scarce resources (RF and Numbering) require horizontal rules. Individual licences are needed for rights-of-use of frequencies; the authorisation gives rights (such as rights to use spectrum and numbers) and also obligations (consumer protection).

Regarding e-Communications, the EU is the supranational framework of 27 countries. It is not a federation like the US, nor is it simply an organisation for co-operation between governments, like the United Nations; it is unique. The countries that make up the EU pool their sovereignty, in order to gain the strength and world influence that none of them could achieve on their own. EU institutions have the power to set framework rules for regulation in the Member States (Hall, Scott and Hood 2000:107). Access to RF spectrum is one of the grounds that justify individual licensing regimes, pursuant to EC Directive 1997/13/EC ('Authorisation': Section III Individual Licences Article 7 Scope 1). In RF the EC has succeeded in centralising authority to regulate inter-state and foreign commerce by wire and radio towards a federal Europe. The EU RF rules are emulated also by Latin America, Arab League, Franco-African ex-colonies, and Asia- Pacific countries.

EU policies consist of the tasks assigned to the Community in Articles 2 to 4 of the EC Treaty (Larouche 2000:xxxvi). Disputes occur within the EU since Member States move at different paces towards RF harmonisation. But the advantages of harmonising one wireless market are clear to its members. It is important to note that in other areas, France, UK and Europe are less harmonised. The EU view honours cultural boundaries but implies unification. This EU policy is implemented in RF as the diversity can be kept minimal. EU countries are seeking more general, less specific allocations and 'lightly' regulated blocks of spectrum. RF may serve as an example of rules and regulations for policymakers on how to implement the harmonisation (and perhaps also the US federalisation, '*E Pluribus Unum*'[32]) of Europe in other areas.

The R&TTE achieves simple market access, harmonisation and contributes to a 'Federal' Europe in e-Communications; it is a revolution in free circulation of radio equipment and single market in Europe. The one EU market policy created the RF harmonisation, R&TTE Directive and GSM; the GSM serves the interests of European citizens and industries well.

This success may be employed as a sub-regional model for current and next generation e-Communications networks and services.

Supremacy of EU over National Regulation

EU is much more than a customs union, but much less than a government; it could be characterised as a treaty of organisations with some ‘quasi-federal’ aspects of sovereignty, that its Member States have agreed to entrust to the community constitutions. Governments participate in the legislative process (primarily by voting in the European Council) and they are then obligated to Community measures in effecting their respective legal and administrative regimes. The interaction between the Community institutions and national governments is consequently complex, dynamic and variable (Gilles and Marshall 1997:561). In principle, the EU legal framework does not allow for any exceptions; however, the detailed national legislation in various countries may differ. The primacy of European legislation (Cave 2002:B.3.2.1) over national legislation produces both opportunities, such as those offered by European harmonisation, and constraints for each Member State, namely the imposition of 'essential requirements' for all equipment. EC Directives may be found to contradict the national regulation, e-Communications or other services (such as transport, defence, industry) laws. Therefore an interesting question may arise (the answer is beyond this study): in front of a national court which legislation (in the supranational / national levels) would be in force?

2.3 Europe Regulatory Framework (All Europe including EU): Conclusion

European countries follow similar RF regulation, are bound by the same EU directives, and implement CEPT regulation. European regulation is executed mainly by CEPT and EU. The permanent bureau of CEPT (ERO) coordinates the main harmonisation and allocation activities. Telecommunications administrators meet frequently in ECC, ERG, RSPG, RSC and IRG committees. EU bodies (like RSPG, RSC) take the lead on co-ordination of detailed aspects of regulation across Europe.

The high population density within Europe and the large number of countries necessitate RF harmonisation. The sense of belonging felt by the European Member States is an important parameter in defining the level of its European harmonisation. CEPT and EC set the European RF intergovernmental framework; while the CEPT regulation is non-binding, the EU sets binding measures. The RF spectrum harmonisation, R&TTE Directive, GSM/UMTS and DVB-T technologies are the main promoters of one single European market for telecommunication.

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[32] ‘Out of Many, One'; this message is carried by the American Eagle.

As the EU wireless directives, decisions, recommendations, opinions and reports are so detailed, and the European allocations are made at the CEPT level, there is a need to update the role of the European National Regulatory Authorities (NRAs). Usually regulators solve problems arising from specific needs; however, the European organisations advocate a liberal telecommunication policy, creating an assertive top-down pressure so that national administrations implement the harmonised regulation. This top-down liberal policy is not the result of a bottom-up pressure from the public or industry to solve critical problems. European countries that are not members of EC follow EU regulation even though they are not obliged to do so. In wireless communications Europe is practically one harmonised federation. Europeans are more allied on RF regulation than they are on other issues (such as single currency, border crossings and subsidies to farmers).

NRAs participate in the e-Communications process at an supranational (EU) and international level (CEPT). EU and CEPT are coordinated in radiocommunication. EU provides guidance and priorities to its members within CEPT (and for ITU World Radio Conferences' preparations), and also asks for support from CEPT when deemed appropriate. Harmonised RF is important for the European economy, employment and its citizen-consumer policy. In this way, Europe achieves interoperability, economies of scale and improved spectrum coordination. In Radiocommunication markets where mass production of equipment is required, RF harmonisation is essential for manufacturers, operators and users. GSM is the prime example of the success of the harmonisation policy.

EU regulation is implemented in Europe, but also outside the EC; East European and ex-USSR countries seem to be keen to follow the rest of Europe. The influence of the EU regulation is conclusive in EC, dominant in Europe, and strong in Africa and West Asia (as they belong to ITU Region 1 and are bounded by the same RF allocations as Europe). European RF rules and standards compete with that of the US in East Asia (e.g. China), Oceania (e.g. Australia) and in South America. This research explores whether the exceptional EU model, as a result of which countries relinquish some of their sovereignty, may be repeated in other continents.

3 RF Regulatory Framework in South America

3.1 Intergovernmental South America

3.1.1 The Main Regional Organisations in South America[33]

<u>*OAS (Organisation of American States) and CITEL*</u>

OAS is the oldest regional organisation in the world and encompasses the Caribbean and Central American countries, as well as North and South America. It is included in this section as OAS influences all South American countries. CITEL serves as the coordinator for the OAS in matters concerning telecommunications; the organisation works both with governments and the private sector. It has been entrusted by the heads of state at the Summits of the Americas with specific mandates to intensify its activities in key areas. CITEL has a Permanent Executive Committee (COM/CITEL) consisting of eleven members, three Permanent Consultative Committees (PCC) and one working group. At present, 35 American States have ratified the OAS Charter and are Member States of the OAS and, thus, also members of CITEL; over 200 companies are Associate Members.

<u>*South American Community of Nations- CSN*</u>

Figure 3-1 The States of CSN *(Comunidad Sudamericana de Naciones)*

The *CSN* is a new South American organisation of Member States[34] with the intention of unifying South America as a whole. At the South American summit of December 2004 the declaration was made that the *CSN* will be a continent-wide free trade zone that will unite the two existing intergovernmental organizations *CAN* and *Mercosur* (*Mercado Común del Sur*), in order to eliminate tariffs for *non-sensitive* products within ten years and *sensitive* products within fifteen years. Here again Simón Bolívar is the historical precedent[35].

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[33] Pan-American OAS and CITEL are mentioned as they influence directly the regulation of South America.

[34] Four *CAN*: Bolivia, Colombia, Ecuador and Perú; five *Mercosur*: Argentina, Brasil, Paraguay, Uruguay and Venezuela; three associated: Chile, Guyana and Surinam.

[35] Peru President on 8 Dec. 04 (the *CSN* creation): we are here to realise the dream of Simón Bolívar.

The Southern Common Market- Mercosur

Figure 3-2 The States of *Mercosur*

Mercosur[36] (also known as *Mercosul* in Portuguese) is a trading zone comprising four countries: Brazil, Argentina, Uruguay and Paraguay. Its purpose is to promote free trade between these countries. *Mercosur* was set up with the ambitious goal of creating a common market/customs union between the participating countries, on the basis of various forms of economic co-operation that had existed between Argentina and Brazil since 1986. Bolivia, Chile, Peru, Venezuela and Mexico have associate member status. In 2003, several important events contributed to the strengthening of *Mercosur*: the newly elected presidents of Argentina and Brazil, Presidents Kirchner and Lula da Silva have put *Mercosur* at the top of their political agenda.

Other South American Players

AHCIET[37] is a private organisation; it includes 50 Spanish-speaking telecommunications operating companies across 20 countries in Latin America and Spain. The involvement of Spain illuminates the strength of the link to that country and its language. AHCIET is the contact point for synchronising activities, products and services. AHCIET cooperates with international vendors and operators in order to assist with regulation, and to promote new technologies and the global information society.

36 *Mercado Común del Sur*: Southern Common Market.

IIRSA[38] comprises twelve South American countries: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay and Venezuela; the four *CAN* (*Comunidad Andina de Naciones*) countries are part of IIRSA (and OAS). IIRSA's managed sectors are: air transport, border crossings, financial instruments, maritime transport, multimodal transport, regional energy markets and ICTs (Information and Communication Technologies).

The Inter-American Development Bank is a long-standing initiative of the Latin American countries. It was established as a development institution for economic and social advancement projects. The Bank is the main source of multilateral financing for economic, social and institutional development projects as well as trade and regional integration programs in Latin America and the Caribbean.

REGULATEL is a Latin American forum of telecommunications regulators, acting to improve the cooperation and coordination among its nineteen Member States.

Simón Bolívar, the South American Ubermensch[39]

Simón Bolívar stated on 6th September 1815: 'to form in the new world a single nation with a single bond that binds its parts to each other; one origin, a language, customs and a religion; therefore, a single government who confederates all the states'. Bolívar's ultimate goal was the unification of South America. The Republic of *Gran Colombia* 'Great Colombia' (Colombia, Venezuela, and Ecuador) was founded in 1819 when Simón Bolívar fought to liberate these countries from the Spanish colonialism. In August 1819 Bolívar, known as *'el Libertador'*, left to liberate Peru and Bolivia as well[40]. The 'historical mandate', sovereignty and independency are mentioned in the Cartagena Agreement. *CAN*'s ideal could be Bolívar's *Gran Colombia* 1819-1830; Bolivia preserves the name of Simón Bolívar and Venezuela is called the 'Bolivarian Republic of Venezuela'. The *CAN* Satellite project is also called 'Bolívar' and *CAN* decision 563 created the Simón Bolívar Andean University.

3.1.2 Intergovernmental South American Overall Approach

South America was colonised mainly by Spain; after gaining independence, the cultural background and heritage did not disappear. South America is connected to USA, but is linked also with Spain. The Latin American Free Trade Association (LAFTA) has governed their trade for more than 40 years. No decision has been made yet (except Brazil) regarding digital TV. In addition to GSM (in all South America), the cellular systems are currently

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[37] The American Hispanic Association of centres of investigation and companies of telecommunications.

[38] Initiative for the Integration of South America region.

[39] Coined by Friedrich Nietzsche 1872 *The Birth of Tragedy* http://fusionanomaly.net/friedrichnietzsche.html 4/1/08. "Roman statesman Julius Caesar, French emperor Napoleon may serve as models for Over/Superior-men".

[40] Therefore Simón Bolívar was personally engaged in all *CAN* 's countries.

operating under both US (TIA-95 CDMA) and European (TETRA) standards. South America operates both NTSC and PAL standards for colour TV; see Figure 3-4 p. 95. Although each country retains its own sovereignty, there is a noticeable influence by the US on South America. This influence is predominantly economic, technological and cultural. The International Monetary Fund (IMF) is administered by the US. The US FCC regulations are followed in general, while not as strictly as in Canada, Mexico and Panama. The US, Canada and Brazil dominate the ITU Region 2 RF allocations. Until the end of 2007, the US had not succeeded in creating the 'Free Trade Area of the Americas' – FTAA.

The influence of Spain on South America is clear in the light of the common language, religion and legal origin; however, there is no direct Spanish influence on the radio regulation and RF standards in South America. There is a strong correlation among the South American cultural attributes: the Spanish language, Catholicism and the *civil law*. The American countries are ex-colonies of Spain, UK, France, Portugal and the Netherlands. British ex-colonies appear to have established 'better institutions'[41]. Britain colonised territories that were suited to settlement; this meant that British ex-colonies could later inherit better *regulatory framework*. Soon after the conquest, the Spanish crown 'set up a complex mercantilist system of monopolies and trade regulations to extract resources from the colonies' (Acemoglu *et al.* 2001:8). The Spanish colonialism emphasised Catholicism and the religious mission; while the UK promoted the infrastructure, industry and market forces in the US and Canada. 'A history of British rule has generally a positive relation to good governance' (Licht *et al.* 2004:15); 'As with Rome, the world accepted the British empire because it opened world channels of energy for commerce in general. … On the whole England's invisible exports were law and free trade' (Paterson 1993:121).

In South America there is sensitivity towards external intervention. Post-colonialism is responsible for this, along with other characteristics such as economy and external powers influencing the South American countries. Telecommunications equipment is not locally manufactured, but imported. The US and EU provide aid and credit for Latin America; it is their way of introducing their products into the markets. The technologies, regulation and standards are generated mainly in the US or in Europe. Commercially, Latin America is oriented towards both Europe and North America. South America applies the same RF allocation as North America, since they belong to the same ITU-R Region 2. When South American countries draft a new regulation (new allocation, new service regulation, etc.) they first turn to the FCC Regulations; they are also inspired by Mexico, Brazil, and other South America countries. Brazil is a sufficiently large country to be able to follow its own path, being the only Latin America country to contribute to ITU-R Study Groups. Europe also influences South America; the EU regulations are already written in Spanish, and this could be adapted and utilised for the benefits of South American citizens. However, most of the wireless standards of the EU can not be adopted directly, as the RF allocated bands and RF bandwidths[42] in ITU Region 1 (Europe) are different to those of Region 2 (Americas).

The regulation and standardisation organisations operate with no coordination or harmonisation in the Type Approval process. There are thirteen national Latin American standardisation organisations[43]. South American RF harmonisation could reduce the workload of and the need for so many institutes in wireless standardisation. Poor and developing countries regulate the most; the regulation in much of South America is cumbersome; stricter regulation is associated with lower productivity, informality, corruption, higher costs and delays (World Bank 2004: Figures 1,2,3,4 and 7.1). In spite of all integration efforts, South American countries nevertheless advance at their own pace. *CAN* countries might see the Incas and *Gran Colombia* as their super-ego, and Simón Bolívar might be the '*Ubermensch*' of South America. The Catholic religion is not clearly separated from the state in South America, for example, the Argentine Constitution Article 2º states that the federal government must practise the Roman Catholic religion. Relative to other continents, South American countries participate in many regional organisations, for instance, Ecuador is a member of four regional institutions (UK is a member of only three). Figure 3-3 is an outline of the regulatory levels in America, superior to *CAATEL*, the Andean Committee of Telecommunication Authorities.

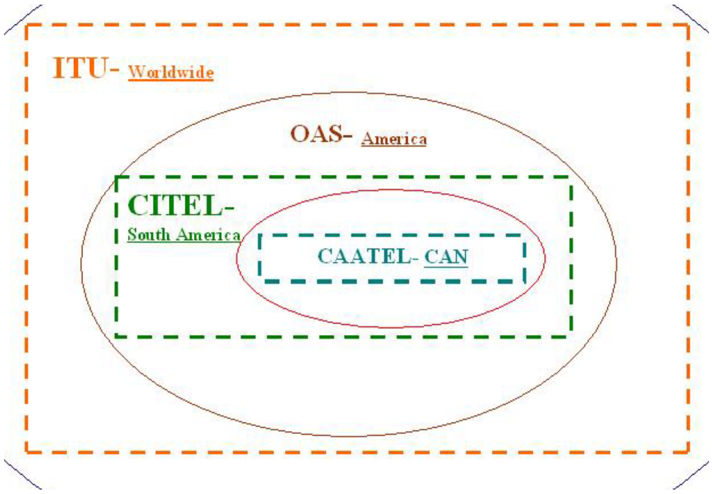

Figure 3-3 *CAATEL and higher levels*

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41 La Porta *et al.* (1998), quoted by Acemoglu, Johnson and Robinson (2001:21-2).

42 For broadcasting sound (100 KHz channel separation in Europe versus 200 KHz in America) and video (7/8 MHz in Europe and 6 MHz in America).

43 http://www.calidad.com.ar/calid079.html 15/08/04 Argentina, IRAM; Brazil, ABNT; Chile, INN; Colombia, ICONTEC; Costa Rica, INTECO; Cuba, NC; Ecuador, INEN; Jamaica JBS; México, DGN; Panamá, COPANIT; Trinidad and Tobago, TTBS ;Uruguay, UNIT; Venezuela, FONDONORMA.

Except ITU RJ-1981 broadcasting plan for AM radio, there is no South American (international or regional) allotment plan for broadcasting or land mobile. Unlike the European plans: ST-1961 (for TV), ITU GE-1975 (Medium Waves, also for Asia and Africa), GE-1984 (radio FM), Vienna-1992 (for land mobile), Wiesbaden-1995 and Maastricht-2002 (digital radio), Chester-1997 (digital TV) and RRC-06 (digital TV also for all Region 1 and Iran). The dissimilarity in regional plans demonstrates the difference in *regulatory framework* and harmonisation across the Atlantic.

South America is aligned vertically, in a North-South direction, like Africa and Chile, unlike Europe and the US. The difference in latitude may explain the divergence in economy, regulation and ruling among South American countries.

Chile's Isolation: The case of the vertically aligned Chile -like Japan, Israel, UK and Scandinavian countries- is interesting. Till 2006, Chile is not a Member State (accepted as associate member on 20 September 2006) of either *CAN* or *Mercosur*, while being active in FTAA, NAFTA and the Pacific commerce. With Argentina, Chile leads the cellular penetration rate in South America: in 2006 Argentina had 80.5 per 100 inhabitants, Chile 75.6, Suriname 70.8, Venezuela 69 and Uruguay 66.8; see Figure 3-6 Latin America: Cellulars/100 inhabitants p. 97. Chile has a strong economy and is most interested in commercial issues, far beyond *CAN*. With 70% of its GDP attributed to foreign trade, Chile has traditionally favoured relations with the US or the Asia-Pacific Economic Cooperation forum over South American agreements. The Chilean isolation is rooted in its economic and political change, since Pinochet led a *coup d'état* in 1973. However, the RF allocation of Chile is not unique, as in Japan. The isolation of Chile from South America may also be explained by their geographic frontiers: the oceans to the west and south, and the high Andean mountains in the east. Despite the long frontier with Argentina, no radio FM coordination takes place between these countries; TV emissions are only coordinated between the countries in specific cases, such as in the province *Tierra del Fuego* (South of Argentina and Chile), where the Andes range is not so high. The isolation of Chile from other Andean and South American countries can be compared to the isolation of the British Isles from the European mainland, and that of Japan from Asia. Moving in a North-South direction entails traversing different ecological and climatic zones (Rigobon and Rodrik 2004:11). Perhaps the **change** in climate zones within a country engenders isolation from one's neighbours, whereas, no change in climate (tropical countries) guides to conservatism; more study on this topic is necessary.

South America: Geography and Geo-policy Influence the Adoption of TV standards

The adoption of different analogue TV standards across South America reveals the influence of geography and geopolitical factors in this arena. The entire continent of North America, as well as many of their close neighbours in Central and South America, have adopted the US NTSC standard. Nearly all countries in Europe, East Asia and Australasia use the most popular PAL system. South America is divided longitudinally between those countries west of the Andes which have chosen the US system NTSC, and the four *Mercosur* states in the east (Argentina, Brazil, Paraguay and Uruguay) which have chosen the European PAL, following a technical evaluation process. The adoption of PAL may also indicate a counter-reaction to the US geopolitical influence. Retrieved from the *Indicators data-base,* Figure 3-4 points out that the distance to the US might affect the adoption of the NTSC standard.

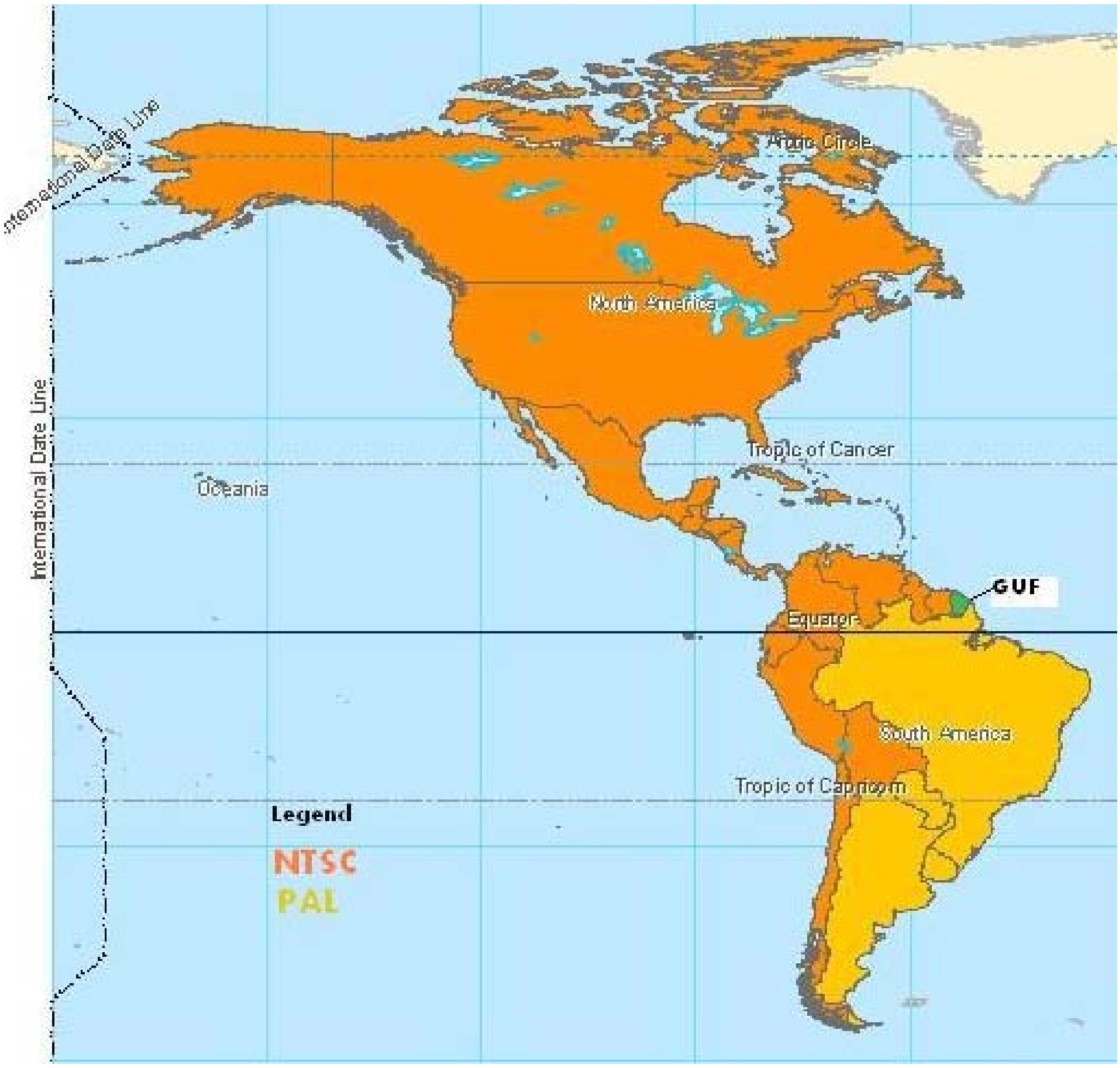

Figure 3-4 Analogue Colour TV adoption in the Americas

The west side of South America is geographically closer to the US and separated by the Andeans mountains to the east. During the NTSC adoption, the west was more influenced by the US, whereas the eastern geographical area - the Atlantic Coast, nearer to Western Europe and comprised of larger countries, such as Argentina and Brazil- could resist the US pressure; Brazil also preferred the Japanese ISDB-T digital TV over the US ATSC. In addition, the satellite broadcasting signal covering North America and the west part of South America is well received only if the receivers employ the same US standard NTSC; this is also the case for the east part of South America, getting the PAL signal from the European satellite. Moreover, all the countries on the western side of South America speak Spanish (including *CAN* countries); in the East they also speak other languages (Dutch, English, French and Portuguese).

The 50/60 Hz mains electricity in South America also reveals different geopolitical influence: 50 Hertz (like PAL standard) reflects the European influence. There is a link between the mains electricity and the TV standards; see the RF section in the *Introduction* chapter. Retrieved from the *master-data*, Figure 3-5 illustrates that most countries in the Americas use 60 Hertz and NTSC; however 44,4% of countries applying 50 Hertz operate PAL. The uniqueness of Brazil is exposed: it is the only country with 60 Hertz using PAL. There are only five American countries operating SECAM: French Guiana, Guadeloupe, Haiti, Martinique, and Saint Pierre-and-Miquelon; Haiti is the only sovereign Member state in the ITU; it applies 60 Hertz; the other four are under French sovereignty and apply 50 Hertz; all five speak French (and drive on the right-hand side).

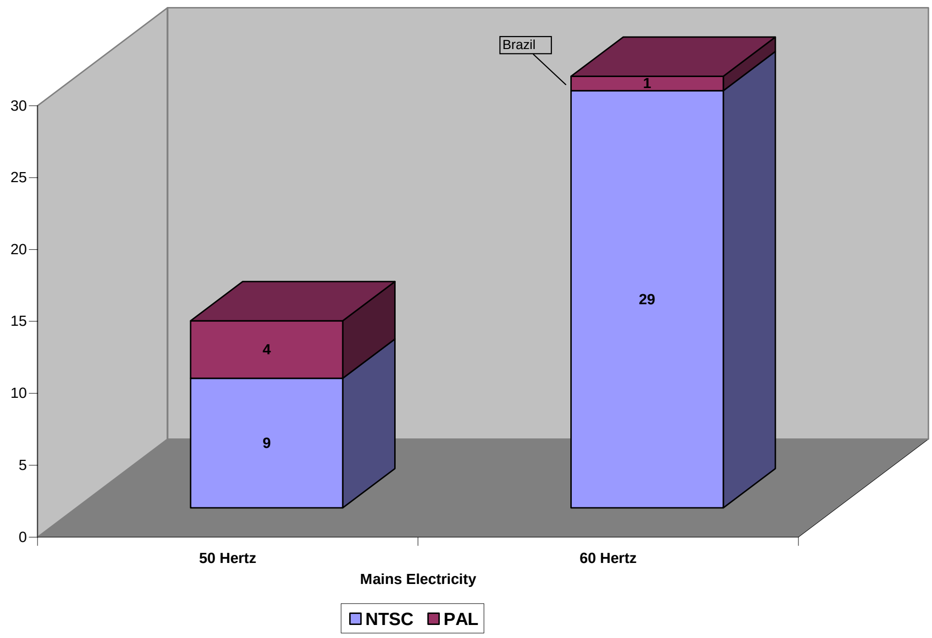

Figure 3-5 Analogue Colour TV versus Mains Electricity in the Americas

The choice of digital TV in South America may obey political, economic and technical factors; South American countries may follow Brazil. Brazil chose the Japanese digital standard (ISDB) mainly for technical reasons, as well as some economic considerations (like the fact that Japan will install a semiconductor factory in Sao Paulo). Brazil's choice is backed by many field and laboratory tests and by a public consultation[44]. Thus, Brazil is moving from the European PAL to the Japanese standard.

South American Indicators

Except for Canada, Chile, Falkland Islands (Islas Malvinas), Saint Pierre and Miquelon, USA and Uruguay, all other 41 American countries are tropical states. All American countries are Christian (except Suriname); North America is Protestant applying the *common law*. All South American countries are Catholic (except the British Falkland Islands which is Protestant and Suriname - Hindus) and apply the French *civil law* (except Falkland Islands - *common law*). Portugal, France, Netherlands and the UK are also influential in South America. With the exception of Brazil (Portuguese), Falkland (English) and the Guineas (French Guiana - French, Guyana - English, Suriname - Dutch), all South American countries speak Spanish. North America, Central America and the northern part of South America mainly operate 60 Hz electricity (see *master-data*). ICNIRP (International Commission on Non-Ionizing Radiation Protection) is most influential on the *human hazards* limits. Figure 3-6 depicts the cellular penetration rate in Latin America. Chile is the most advanced, while Bolivia and Paraguay trail; see Appendix B: *Master-Data*.

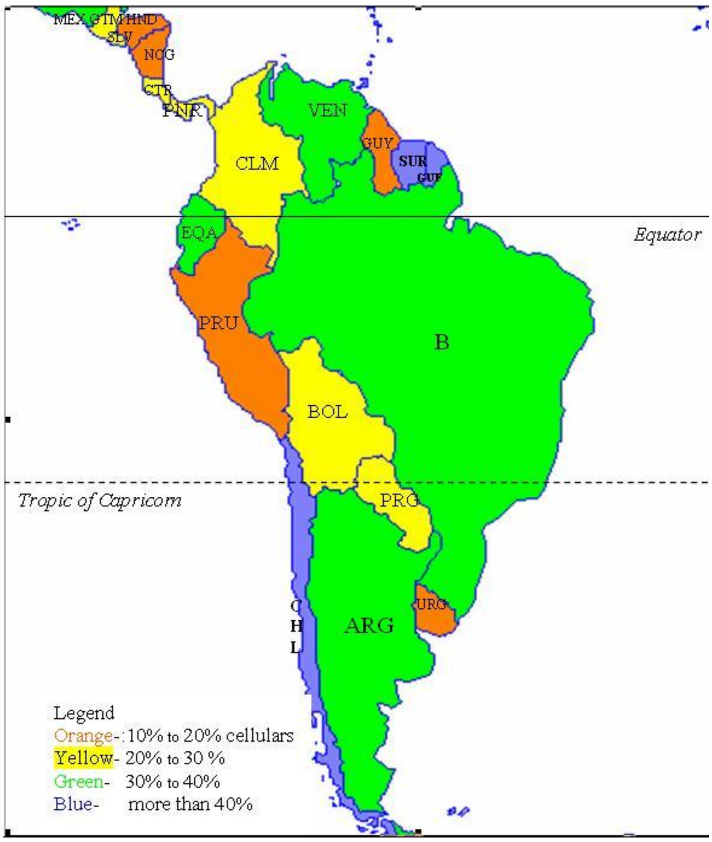

Figure 3-6 Latin America: Cellulars/100 inhabitants (ITU-D data, most recent 2002/3/4)

[44] On 8 Nov. 06, during the ITU Plenipotentiary, the Minister of Communications of Brazil, his Excellency Hélio Costa, informed the author that the mobility advantage of ISDB-T and the technical test in Sao Paulo on 2006 were the major reasons for its choice.

Geography, Religion and Legal Origin: South versus North America

Figure 3-7 depicts the verticality of South America and the significance of the Andean mountains as a natural obstacle for RF signals; Chile is isolated by the oceans and by the Andes. Bolivia and Paraguay have no coastline.

Figure 3-7 South America Topography (http://www.google.com/maps 12/12/07)

The *regulatory framework* of wireless communications in North America (see next chapter, the US *case study*) is more developed than in South America. The regime theorist Stephen Krasner (1985) claimed that *southern* developing countries sought to gain distribution resources by means of administrative allocation through international institutions, rather than by means of markets (Hills 2002:8). This observation is indicative not only to compare the *collectivised* Southern Europe and Southern America versus *individualised* Northern Europe and Northern America, but also the latitude's impact. The division between North America and South America is articulated in religion (Protestant versus Catholic), legal origin (*common law* versus *civil law*) and language (English versus Spanish). The Latitudinal differences may hint at the successes of the EU in e-Communications as compared to *CAN*, and North America as compared to South America. The main contribution of Latitudinal attributes is through income. However, there are Latitudinal interventions explained by the post-colonialism of the UK and France in North America fostering 'means of markets', versus that of the Spanish and Portuguese in South America favouring 'administrative' processes.

Of the thirteen South American countries (including French Guiana) only three (Argentina, Uruguay and Chile) are not tropical countries; none of the thirteen countries is classed as

Developed. A complex social Developmental progression has benefited the temperate zones much more than the tropics. South America suffers from a large gap in income within its countries and between the temperate zone and the poorer tropical zone; there is a difference also in trade-openness and institutional quality as the distance from the Equator greatens (Sachs 2001:10). Tropical underdevelopment touches Latin America, Africa and Asia (see *Indicators* chapter). The temperate zone countries (ARG, CHL and URU) possess a similar absolute latitude and climate to Europe and the European offshoots such as the US, Canada, Australia and New Zealand. Those South American countries outperform *CAN* countries and provide a different *regulatory framework* to all other tropical countries (positioned north of the 'Tropic of Capricorn'[45]) in South America. Culture, economy, technology and e-Communications diffuse more easily within ecological zones (such as *CAN*), but not across ecological zones and through the tropical regions (such as from Chile to Ecuador); see Sachs 2001:22. The technological advances, innovation, penetration of new technologies, economic and military power are directly connected to wireless regulation, and also linked to the absolute latitude. The distance from the Equator is the preferred measure of geography (Rodrik, Subramanian and Trebbi 2002:3); countries located far from the Equator are considered to be richer (Rigobon and Rodrik 2004:5).

The French and Spanish regulation and legislation follows the Roman worldview of central planning; the UK and the US emphasise the market-based rationality and property rights (see next chapter, *Case Studies*). Judicial complexity and formalism may engender a bad *regulatory framework*; some researchers relate the difference between north and south in America also to the British *common law* versus the Spanish *civil law*. Based on a study of the World Bank - The Lex Mundi Project (Djankov, La Porta, Lopez and Shleifer 2003), in 109 countries, including 25 countries in America- Pedro Galindo (2001:2) (see also Zimmermann 2001 and Lerner 2004) demonstrates that the juridical process and the regulation in South American[46] countries under *civil law* are systematically more complex, slower, less transparent and more corrupted than in American countries, where the judicial system is based on the English system of *common law*[47]. The results suggest that legal transplantation may have led to an inefficiently high level of procedural formalism, particularly in developing countries (Djankov *et al.* 2003:5). Economic historians have argued that poor institutions are a consequence of underdevelopment, and only development itself brings about improved institutions, including the legal system (Djankov *et al.* 2003:30); heaviness

45 The sun is directly overhead at noon on the Tropic of Capricorn, on ~Dec. 21 'solstice', the beginning of summer in the Southern Hemisphere; latitude ~S23^{0}26.

46 Argentina, Bolivia, Costa Rica, Guatemala, Panama, Peru and Venezuela participated in this project.

of regulation, interventionism and bureaucratic inefficiency are linked to the *civil law* (Djankov *et al.*:35). However, as it is difficult to separate between the Spanish and English inheritance and legal origin, there might be other reasons to explain the discrepancy: English versus Spanish colonialism, Protestant versus Catholic religion and absolute geographical latitude (distance from the Equator). *Common law* countries are located further from the Equator. Based on the *master-data*, Figure 3-8 illustrates that all 15 American Protestant countries apply the *common law*, about 80% of Catholics apply the *civil law*. Therefore, the religion (instead of or in addition to the legal origin) may serve as a leading explanatory indicator of the Lex Mundi results; namely that given the religion, the legal origin may not be the independent variable. The divergence of Catholicism and Protestantism (see Max Weber's 1904-5) is analysed in the *Indicators* and *Discussion* chapters. Statistically, the hypothesis on correlating latitude to legal origin in America is rejected; the average latitude of the *common law* countries is indeed higher (latitude 21.5 degrees, standard deviation 10.2) than that of the *civil law* countries (16.4 degrees, 13.1); however, due to the high variance of the averages, the difference is not statistically significant[48].

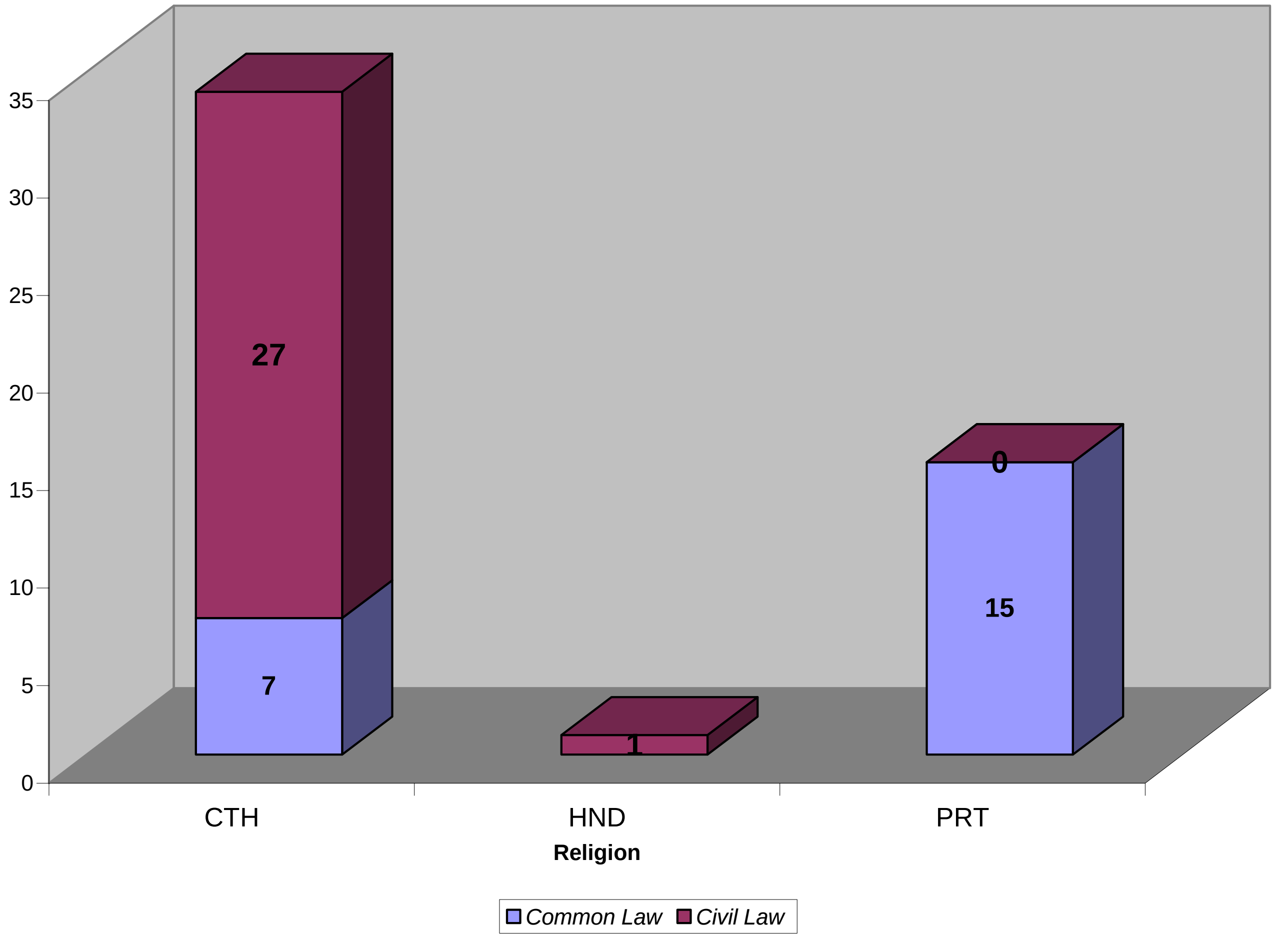

Figure 3-8 Religion versus Legal Origin in the Americas

[47] Barbados, Belize, Canada, Grenada, Jamaica, Trinidad and Tobago and the US.
[48] The lack of observations can explain the high standard deviations.

3.2 RF Regulatory Framework in CAN

Figure 3-9 The States of *CAN*

The 1969 Cartagena sub-regional integration agreement established *CAN Comunidad Andina de Naciones*, with the present Member States Bolivia, Colombia, Ecuador and Peru; see Figure 3-9 . Chile left the Pact on 30 October 1976, Venezuela left on 22 April 2006. Chile, Argentina, Brazil, Paraguay and Uruguay are associate members; Mexico and Panama are observers. *CAN*, like South America and the pre-Columbian 1197–1572 Inca Empire, is aligned vertically. The key telecommunication player is CAATEL (*Comite Andino de Autoridades de TELecomunicaciones*). The Andean Committee of Telecommunication Authorities is charged with the study and proposal of Andean telecommunications policies, in order to facilitate the interconnectivity of these services. In coordination with ASETA (the Andean Association of Telecomm Service providers), CAATEL implements the sub-regional policies. The agreements created by CAATEL are employed through resolutions. The members of CAATEL are the Telecommunications Authorities or regulators in the *CAN* countries, or their subrogating countries.

3.2.1 CAN- Common Market and Liberalisation in Telecommunications

In Decision 462 of 1999 'Integration and Liberalisation of Trade in Telecom Services', *CAN* agreed to deregulate all telecommunications services, with the exception of sound radio and television broadcasting, in order to remove all obstacles to free trade in the sector. This is one measure taken to bring about the unimpeded circulation of services, persons, goods, and capital among the *CAN* states, in order to create a common market. This target was set by the Cartagena Presidential Summit in May 1999, and later ratified in Lima in June 2000. The achievement of a single market would be the highest phase of *CAN*'s integration, characterised by the free circulation of goods.

Free Circulation of Goods and Services

CAN has its own provisions to determine the origin of goods (see Decision 416- Special norms for the qualification and certification of equipment) and the conditions that products must meet in order to be considered of sub-regional origin and thereby benefit from the extended market. Trade among the Andean countries was governed for almost two decades by the provisions of origin of the Latin American Free Trade Association (LAFTA), in force since 1960. The countries committed themselves to periodically updating the inventories of products with such technical regulations and the accredited and recognised certification institutions that are responsible for evaluating their conformity. Efforts have been made towards the gradual and progressive liberalisation of the trade in services, particularly in the transportation and communications sectors. This process intended to slowly remove the measures that hinder market access. The Andean countries are currently trying to put this into practice so that the Common Market may be established soon. In order to accelerate this process, *CAN* approved agreements in the transportation, energy, and telecommunication sectors through the South American Regional Infrastructure Integration Initiative (IIRSA). Free circulation and "technological transplants" must be reflected also in legal transplants; the harmonization of technology should be accompanied by the harmonisation of the law.
In practice however, there is currently no free circulation of goods and services in *CAN*.

Equipment Type Approval

The EU R&TTE Directive demonstrates the link between Type Approval (TA) and the free circulation of wireless equipment. In the *CAN* countries, TA is regulated by Decision 462-1999. TA is indispensable for entering radio equipment into a market. Measures are taken to prevent damage to the public networks, avoid interference to other systems, and guarantee the user's safety and access to the public networks and services. Wireless equipment must fulfil the ITU and CITEL recommendations. Licensees are required for TA; they may also get TAs in another country of the sub-region. TAs are registered in CAATEL. Every country provides its own specific TA; there is no unified *CAN* standard. The TA process should not exceed 90 days, unless there is a need for special proceedings. The homologation qualifies the item only for the services authorised. The approval process of compliance, verification, specifications and homologation bodies appears in CAATEL resolution II-8. In practice there is not a real single market for wireless equipment; there are more declarations made than actual harmonisation and free circulation.

3.2.2 CAN: Overall approach

CAN is a 'geo-cultural region'[49]; *CAN* members are self-identified by 'a common history, a shared legacy (cultural, material and immaterial heritage), geography, a common language, common ideal, goals and objectives'[50]. *CAN* was established mainly to promote a single market for the prosperity of the citizens. The integration constitutes a historical, political, economic, social, and cultural mandate, in order to preserve *CAN* sovereignty and independence. *CAN* looks ahead to the gradual formation of a Latin American Common Market (Decision 563, 25 June 03), and socially, aims for globalisation of all Latin America.

Article 22 of Decision 462-1999 states the scarce resources of every nation: RF spectrum, numbering, identification codes and physical facilities. Their allocation should follow the national regulation and should be appropriate, objective, transparent and non-discriminatory. Every nation should publish their utilisation of the RF bands. Each country of the Andean Community has sovereignty over the use of RF spectrum, following the regulations and technical rules of the ITU. The administrative and legal frameworks are specific to each country.

Liberalisation and the launch of the Simón Bolívar satellite have proved to be the main advances in telecommunications within the Community. *CAN* has adopted a series of provisions on telecommunications that regulate the liberalisation of trade (Decision 462) and lay down the legal foundations for the operation of the Simón Bolívar satellite (Decisions 395, 429, 479, and 480). *CAN* encourages competition; in telecommunications, it drives the national regulation towards intergovernmental regulation. *CAN* promotes agreements with other super-national organisations, such as the exchange of information on standards conformity assessments and type approvals; for example on 15 December 2003 *CAN* signed the ‘Political and Cooperation Agreement'[51] with EU; page 33 specifies 'exchanges of information on standards conformity assessment and type-approval'.

The goal of *CAN* is to attain a new policy for every *CAN* state regarding regulation and planning. Biased by the WTO in economic policy, *CAN* **seeks** openness of markets (*laissez faire*), free circulation (*laissez passer),* integration, competition and liberalisation. The organisation **declares** that the success of Capitalism and Liberalisation is the integration of national markets in the interests of preserving peace and enhancing prosperity. It will break down technical and investment barriers at national frontiers, as well as regulate state intervention in enterprise, so that *CAN* industries could realise economies of scale. In order

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49 See this metaphor, without mentioning *CAN*, in Mahoney and Ruesche (2003:423).

50 *CAN* website http://www.comunidadandina.org/ingles/who.htm 16/12/07.

51 http://www.bilaterals.org/IMG/pdf/EU-Andean_PCDA_2003_.pdf 16/12/07.

to promote harmonisation, roaming and interoperability in *CAN*, CAATEL allocates scarce resources such as RF spectrum and numbering according to ITU and CITEL rules. *CAN* **tries** to harmonise technologies and RF spectrum for the advanced cellular services; it does not disregard the European standards UMTS (Resolution CAATEL-XIII-EX-58 i*mplementing IMT-2000*) and TETRA; the American Personal Communications Service (PCS) is also promoted (Resolution IX-54; Mobile Services in *CAN*, 9 July 1999).

The dissent among *CAN* countries (and Latin America) is rooted in the Spanish oppression[52]: the division of the *Gran Colombia* and rivalry between regions. This is in addition to the polarisation of the native *Incas* in the South and *Shyris* tribes in the North. The main obstacles to the intergovernmental *CAN* are different national cultures, lack of institutional direction, sectorial politics, legal regimes and regional asymmetry (Ríos 2001:slide 23). The administrations are concerned about their sovereignty, being anxious not to lose control of their nationality. The standards and intergovernmental regulation are only applicable in the territory of the state that accepts them. In practice, there is no harmonised RF spectrum in *CAN* and no regulated interoperability/ roaming of telecommunications systems. There is no commercial agreement in *CAN* concerning a single market. Today there is no free circulation of telecommunications equipment and services in the Andean Community; however, great efforts are being made to achieve this. The style of regulation in *CAN* and its four states is collectivised rather than individualised.

CAN Regulation: Conclusion

ITU and CITEL are most influential on the regulation of *CAN* telecommunications. Liberalisation of telecommunications and satellite communications are the most common activities under *CAN*'s jurisdiction. Unlike in the supranational EU, the intergovernmental *CAN* holds no supremacy over national regulation of wireless telecommunications. Moreover, RF is not harmonised and equipment standards are still national. Many declarations have been made within *CAN*, but until December 2007, there is no free circulation of terminal equipment in one single market or liberalisation. The four *CAN* countries are tropical, and this might be the reason not to rush for **change**. The RF allocation follows the US Code of Federal Regulations 47 Part 2. The cellular standards are both American and European (CDMA and UMTS). All *CAN* countries have adopted NTSC[53], revealing a clear US influence.

[52] The demarcated zones defined by the Spanish crown: *El Virreinato de* ***Lima***, *la Real Audiencia de* ***Quito***.

[53] Ecuador was the first (20July1969) to operate colour TV in South America, and to adopt the NTSC standard.

The *regulatory framework* of a country or sub-region mirrors in general the economic level and cultural factors of that country. The *CAN* Member States are determined to preserve their autonomy; they are not confident enough to give up their sovereignty, even for RF harmonisation. The domination of the Indians by the white conquerors, the domination of the South American states by Spain, the wariness of the US[54] and some *Bounded Rationality* (given that one single wireless market is rational) may be the reason for this sensitivity. *CAN* countries are concerned about their national identity, and that some external body should not dictate their regulation and hurt their sovereignty; 'national regulation is the bulwark of sovereignty' Hills 2002:292.

Regulation, free circulation and regional harmonisation are interconnected. The harmonisation of the RF spectrum raises questions of sovereignty. Pooling sovereignty means that the Member States delegate some of their decision-making powers to shared institutions that they have created, so that decisions on specific matters of joint interest can be made democratically at the top *CAN* level. If there has been no success in achieving a single market of wireless equipment and harmonising the RF spectrum on this small scale of four countries within the *CAN* framework, how can South America as a whole be unified to reproduce the success of the European Community? Further studies may compare *CAN* to other sub-regional intergovernmental organisations such as the RCC: Regional Commonwealth in the Field of Communication, 12 ex-USSR countries.

3.3 Regulatory Framework in South America: Conclusion

Catholic Spain emphasised religion and the hierarchical role of the state, whereas the UK invested more in infrastructure, the economy and the individual. This could give an impression of the different regimes and *regulatory frameworks* in North and South America. RF regulation follows national regulation. RF is perceived more from a technical than cultural point of view; for this reason the RF regulation and standards can be harmonised more easily (relative to foreign affairs, for example). Despite this, South America has not succeeded in achieving a single wireless market and harmonised RF. The sovereignty is essential for South America; it explains the disjunction and failure of the RF harmonisation. This attitude may be due to the continent's dependence on Spain for more than 300 years.

In practice the FCC RF allocations (but not necessarily the US standards) are applied in South America. The western side of South America, that is closer to the US in distance,

[54] The socialist worldview held by the new leaders Bolivia and Ecuador may repel them from the US, and from adopting the US RF standards.

adopted the US colour TV standard (NTSC), while the eastern side adopted the European PAL standard. South American countries[55] apply European mobile standards as well, such as TETRA and DECT. If the South American countries had not harboured historical hatred toward the US, the FCC Code of Regulation would have probably served as the telecommunications code applied in most countries. The US reminds South American countries of the old imperialism of Spain.

The South American *case study* examined the wireless regulation and standards in tropical developing countries that are Spanish-speaking, Catholic and follow the French worldview of *civil law* and *collectivism*. Chile and Argentina, the most distant from the Equator, lead in cellular penetration, which reflects at the very least their higher income. Rule of law and distance from the Equator are the most significant variables of explaining income (Rigobon and Rodrik 2004:17). The latitude of the country may explain the different *regulatory framework* of Argentina, Chile and Uruguay relative to the rest of South America.

The distance from the Equator, the differences in legal origin (*civil law* in Latin America, and *common law* in Canada and the US), different religions (Catholic in Latin America, Protestant in North America) and the colonial inheritance (Spain/Portugal versus UK/ France) may explain the disparity between South America and North America. The diversity in government and institutions causes the differences in the *regulatory frameworks* for wireless communications, societal concerns and risk. The *Indicators* chapter will provide a broader view of this, to understand tropical developing status, the North-South diversity and the influence of the cultural attributes (language, religion and legal origin). A worldwide data review and comparison will show if the same patterns and conclusions prevail in other continents. The section indicated some examples of *Bounded Rationality*, e.g. superfluous standardisation institutes that restrain the introduction of new technologies. The rationality is intended but not always achieved; the examined substantive or objective rationalities are not optimally adapted to the situation (see chapters *Theories* and *Discussions*).

[55] Argentina, Brazil, Chile, Ecuador, Falkland Islands (*Islas Malvinas*), Peru and Venezuela.

4 *Regulatory Frameworks*: Europe versus South America

4.1 Intergovernmental: South America versus Europe

This section compares and contrasts South America with Europe. In both Europe and South America unification processes are under way; the wireless regulation and standard adoption are indicators of these comparable activities. South America is much more homogenous than Europe in language (Spanish), religion (Catholic) and the legal system (*civil law*). The continent comprises fewer countries (12 relative to 48 in CEPT). There are regional and sub-regional organisations, many declarations and decisions in South America concerning the single market as in the EU, but with no concrete results as yet. The idea of European unification may have been inspired by the Roman Empire (*E Pluribus Unum*): one language (Latin), one religion (Christianity, since the time of Emperor Constantine), one law (*ius civile, civil law*). *Gran Colombia* and the Incas inspire the Andean union. Simón Bolívar inspires the South American unification of *CAN* and *CSN*; Bolívar could bring back to South America the classic ancient Roman influence, through his studies in France, together with the spirit of freedom and liberty.

Super-nationality in Europe and South America tends to discourage nationality and individuality. The homogenisation opposes the individual's unique expression and national regulation. The harmonised wireless equipment and global networked services search for a wider common denominator, and thus lose the unique characteristics of the individual, generation-to-generation and nation. It seems that also in South America there is a battle between globalisation (reflected in super-nationality and perceived as new supremacy) and local cultures (emphasising sovereignty). The developing world in South America is not strong, and fears US imperialism in the form of globalisation. There are only two dominant wireless standards in the world: that of the Europe and the US. The natural regulation and standards in South America could follow the US, since the entire Americas are in ITU Region 2.

Differences in Geography, Culture and even different rationalities may explain why the twelve South American countries may seek to create one harmonised market similar to the EU; but they have not succeeded in harmonising even the RF allocation in the four *CAN* countries. The EU regulation and standards cannot be adopted straightforwardly in South America, as the RF allocations are different; moreover, the European wireless equipment needs transformers for the mains electricity 110 Volts/ 60 Hertz applied in the American Hemisphere.

Table 4-1 contrasts and compares e-Communications in CEPT (intra-national Europe) and the South-American part of CITEL.

Table 4-1 CEPT versus CITEL overall Comparison

	Europe	**South America**
Member States	48	12 *CSN* countries
e-Communications	Since 1959, CEPT	Since 1963, CITEL
Most Dominant for integration	France and Germany	Brazil and Argentina
Aim	Harmonised electronic communications	Facilitate and promote telecoms
Permanent Offices	Copenhagen (ERO)	Washington (OAS)
Latitude influence	Development grows with absolute latitude and distance from Equator	
Longitude influence	Western Europe is more developed	West- operates the US NTSC TV; East- the European PAL
Alignment	Horizontally , like the Roman Empire	Vertically, like the Incas
Convergence	Wired and wireless, Telecommunications and Broadcasting	
RF Harmonisation Free circulation	YES	NO
Liberalisation and privatisation		Towards liberalisation and privatisation
Binding laws	Not Obligatory	

As a balance to the US influence, the European Union has always favoured a strengthening of the process of regional integration in *Mercosur* (and all South American countries, *CSN*), and therefore has supported the *Mercosur* initiative from its very conception in 1991. The EU prefers to associate itself with a parallel bloc, in order to liberalise *Mercosur*, to facilitate trading (preferably with Europe…) and to influence culturally (toward a 'civil society'). The European Commission holds regular meetings with *Mercosur*; for example, on 14 December 2007 on trade issues. EU assists *Mercosur* in 'Technical Norms and Standards' (3,950,000[56] euros), and has become the greatest importer and exporter to *Mercosur*.

4.2 The Regulatory Framework of EU versus CAN

EU is an exceptional and unique example in the regulation of wireless e-Communications. One single market has been created and most wireless network services operate in harmonised frequencies, due to the extensive regulation, standardisation and EC Directive R&TTE. Countries pool their sovereignty in order to achieve economies of scale, interoperability and roaming. This unification is fundamental for the Europeans; particularly so, as they develop RF standards and supply equipment; this is not the case in *CAN*. The EU regulatory process is relatively efficient, whereas *CAN* is characterised by a great deal of activity without much results. The Andean process of integration is similar to that of the EU. From an economic integration (substitution of imports), it has reoriented towards a scheme of open sub-regions; from being exclusively oriented to commerce and investment, it has moved toward integration, including foreign policy, social agenda and citizen participation.

[56]Data is updated to 2002; http://europa.eu.int/comm/external_relations/mercosur/intro/ p. 4, 18 Dec. 2005.

'The past is a pre-quest for devising the most appropriate solution for the future' (Zimmermann 2001:100,110); the splitting of local leadership in the South American Andean Countries, under various *Caciques* (such as the *Caciques* in Venezuela), may elucidate their culture of provincialism and fragmentation, which are the opposite of integration. It may explain why four homogeneous countries in the Andean Community, sharing the same culture, tradition, Spanish colonialism and similar geography (tropical invariant climate, Andean mountains) are unable to agree on a single harmonised market, in comparison to the 27 European Community Member States that have done so. The Andean mountains also isolate the countries from the eastern part of South America. Some of the hurdles in the unification of the *CAN* are not new: Europe also faced similar obstacles and still faces some today, such as different national cultures, different legal regimes and regional asymmetry. In Europe there are also a number of developing countries - this is particularly true in the Europe of 27 Member States; only now it seems that these relatively new Member States are succeeding in Europe.

There is still a raging debate as to whether colonial possession contributed to the economic growth of the colonised areas in America. However, colonialism is a crude indicator and may provide explanations for the differences between EU and *CAN*. Spain promoted Catholicism more than commerce and industry in the *CAN* sub-region, as opposed to the UK's influence on the US and Canada. *CAN* countries are afraid of losing their sovereignty, after hundreds of years of dependence. Moreover, *CAN* countries are wary of imperialism; a similar pressure from the USA and international organisations such as World Bank, WTO and IMF in favour of one liberalised market had different consequences in EU than in *CAN*. *CAN* countries (Venezuela in particular) perceive it as a new form of US imperialism; they lack the confidence of the centralised powers France and Germany who have celebrated their independence for the last 1000 years. The determination for sovereignty may be a reaction to the external hegemony of Spain, during the long years of colonisation. Colonialism cannot solely explain the present position; tropical Latin America had gained independence by the 1820s, and remains without decisive breakthroughs in development. At the start of the 21st century, decolonisation had not yet broken the pattern of tropical underdevelopment (Sachs 2001:11) also in telecommunications. Like the other South American states, *CAN* did not suffer the horrors of the World Wars of the last century. France and Germany understand why trade unification, without frontiers and barriers, with one currency, one legislation(?)[57] and one harmonised RF spectrum are much better than encouraging one's own nationalism. Table 4-2 compares and contrasts the e-Communications of *CAN* and the EU.

Table 4-2 e-Communications Comparison: EU versus *CAN*

	EU	***CAN***
Number of Member States	27	4
Creation	1957, Treaty of Rome	1969, Treaty of Cartagena
Most Dominant for integration	France and Germany	Venezuela (until 2005) and Colombia
Aim	Liberalisation, integration; serve the citizen, single market	
Principles	Open, objective, non-discriminatory, and transparent	
Religion	Christian: to serve the individual	
Absolute Latitude average (standard deviation)	49.00 degrees (7.53^0)	8.25 degrees (6.75^0)
Cellular penetration average (standard deviation)	Year 2003: 79.40 (19.06)	2003: 14.58 (4.7)
	Year 2006: 105.77 (16.32)	2006: 46.59 (18.93)
Human Hazards levels	Some countries aggravate (e.g. Italy)	ICNIRP levels
Ego Ideal, Super Ego	Roman Empire	*Gran Colombia*
UberMensch	Julius Caesar	Simón Bolívar
Cultural Attributes	Multicultural	Spanish language, Catholics, *civil law*
Telecommunication organisation	Mandates to CEPT	CAATEL
Types of Licences	Authorisation (as specified in the Framework Directive);free circulation	Licence, authorisation, type approvals; frontier barriers to goods and services
Type Approval (TA)	Harmonised equipment. Self declarations of the suppliers and importers; R&TTE includes all equipment; common to most of Europe; applied also out of Europe	Some liberalisation (Decision 462), no broadcasting equipment is included in the decision. National limits to operators, need of TA; there is no harmonised TA for all *CAN*
Data Base	No need to manage equipment data in harmonised frequencies	Equipment database is needed
Single market for wireless goods and services	Yes	No
Privatisation and Liberalisation	Yes	Privatisation and steps toward liberalisation
RF Harmonisation	Implemented	Not Implemented; ITU Region 2 RF allocation is used
Convergence	Wired and wireless, e-Communications & Broadcasting	Wired and Wireless; no convergence of broadcasting
Defined Scarce resources	Frequencies and numbering	RF spectrum, numbering, identification codes and physical facilities
Intergovernmental over national regulation	Supremacy of supranational EU	No supremacy of international *CAN*
Binding laws	Proposed by EC and Compulsory by Parliament	No
External influence, from	CEPT, WTO, ITU	US, Canada, Spain, France; CITEL; WTO, ITU

[57] *Ius Commune* (common law- distinct from *common law*) based on the Roman law.

4.2.1 CAN versus EU: Geographical Compare and Contrast

Physical geography and climactic zones may explain some of the differences between EU and *CAN*. The most apparent distinction between North and South America, and *CAN* and EU is the geographical latitude: the Equator is more than 40 degrees distant from the temperate zone countries of EU; 41 degrees separate the average absolute latitude of CAN and EU countries (see Table 4-2). *CAN* is located in the Tropics, whereas all of Europe is north of the 'Tropic of Cancer'. The classification of Tropical Underdevelopment (Sachs 2001:7) is relevant to all *CAN* countries. The weather, non-seasonal variation of the climate (a definition of tropical countries[58]), income, agriculture[59], vegetation, natural resources[60], density of population [in *CAN*, only 19 inhabitants per Km^2 (Ríos 2001:slide 22)], the way of thinking and local rationality may illustrate the different *regulatory frameworks* and cellular penetration in EU and *CAN*. The same geographical factor (North versus South) exists in the place of origin and the source of the colonial rules: the US and Canada were mainly influenced by UK (and France), while *CAN* countries were influenced by Spain, which like Portugal is south of UK and France.

Sachs (2001:22) emphasises that temperate zone countries tend to economic convergence, through a rapid diffusion of technology; but temperate and tropical ecological zones tend to diverge from one another. This is due to higher rates in innovation in the temperate zone combined with low rates of technological diffusion between the two zones. This tendency may explain the success of EU compared to *CAN*. It is interesting to note that Bolivia and Nicaragua have the longest minimum daily rest period mandated for workers (World Bank 2004 Chapter 7) - their capitals, La Paz, lie on a latitude of S16^{0}30' (longitude W68^{0}09'), and the latitude of Managua is N12^{0}00' (longitude W86^0 25'). The *siesta* (and also timekeeping and punctuality) is thus directly related to the climate and the absolute latitude.

Regulatory frameworks EU and CAN: Conclusion

This comparison of wireless communications in EU versus *CAN* reveals profound differences between developed and developing countries in this field. Developing countries strongly protect their producers and prefer 'command and control'. Regulation in developed countries is simpler: the direction of causality is from culture to governance (Greif 1994 and

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58 Herald Tribune 16/04/99*;* although, in the Tropics they experience a kind of change: monsoon /rainy season.

59 Based on 2001 'world development indicators' there is a strong negative correlation R^2 = 0.6748 (see the *Indicators* chapter; figure 2-5), between the percentage of agriculture and the development of the national economy, in *CAN* and in other countries: more agriculture less GNPP and income per habitant.

60 'Given Taiwan's **lack** of resources, its phenomenal expansion in the high-tech arena is the most striking among North East Asia's tech titans' Kumagai and Sweet *East Asia Rising* IEEE Spectrum Oct. 04. Lack of natural resources may explain the expansion of ancient Greece and nowadays of Hong-Kong and Singapore.

Licht *et al.* 2004:30). Which factors guide countries to become developed? The answer could be linked to the variables that mark the difference between EU and *CAN*: geographical latitude, legal origin, religion and language. The study of *CAN* attests that the EU model is unique; countries do not hasten to lose part of their sovereignty; decision-makers preserve their national RF rules and standards; subjectively, it is a rational behaviour.

5 Conclusion: International and Regional *Regulatory Frameworks*

This chapter analyses the global regulation of ITU and the *regulatory frameworks* of wireless communications in Europe and South America. The ITU Radio Regulations define the different RF allocations for the wireless services in these two continents. CEPT regulates the specific utilisation of the RF spectrum in the 48 European states; ETSI develops the standards in every RF band in Europe; the continent is harmonised in its RF utilization. The European Union is active in the RF licensing of its 27 Member States. The European *regulatory framework* formed a federal Europe. The R&TTE Directive enables free circulation of wireless equipment within the European Community. South America is different; the RF allocation is developed by the US, Canada and Brazil. South America is not harmonised in its RF utilisation, or in the free circulation of wireless equipment. CITEL is not dominant in South America unlike CEPT in Europe, nor is there a central standardisation organisation like the European ETSI. Except for an AM radio plan (Rio De Janeiro 1981), there are no unified plans for mobile communications, medium waves, analogue or digital TV in South America, as in Europe. South America adopts both European and American standards. Europe is horizontally oriented and all countries are non-tropical, whereas South America is vertically oriented and most South American countries are tropical. Europe is multicultural, multi-linguistic and mainly Christian. South America is culturally homogenous (language, religion, legal origin and history). Europe, the US and even Japan are influencing South American wireless standards. The strengthening of anti-American leaders in Venezuela and Bolivia has reduced the geopolitical influence of the US, and the probability that its standards will be adopted (such as ATSC digital TV and CDMA2000 third generation cellular). The influence of EU is more dominant in Europe than the influence of *CAN* in South America. The Geography (longitude, latitude and topography) influences the *regulatory framework* and the penetration of wireless technologies. The political and economic drive for unity in Europe shapes the European *regulatory frameworks*; the result in their wireless communications is harmonisation. Latin America is not moving in this direction; preserving their sovereignty is most essential for them; they execute national RF regulation and standards. This can be perhaps explained by the long Spanish control and the reaction which followed independence.

Chapter 3- *Case Studies*

UK, France, USA and Ecuador: Regulatory Frameworks, Societal and Risk Concerns

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Preamble

Regulatory frameworks in UK, France, the US and Ecuador are scrutinised in this chapter. The studies of the four countries display useful theoretical contrasts through their approach to regulation. Their RF allocation and licensing methods serve as cases to study regulatory frameworks for wireless communications in general, and also to understand other national frameworks. The previous chapters indicated that many countries adopt the rules and standards set by the US, France or UK. RF regulation in UK and France has converged and ultimately become similar, as they follow the same RF rules of the EU. In order to understand the present UK and France regulatory frameworks, European regulations were explored in the previous chapter. This chapter covers the formal regulatory frameworks; it compares the four countries as regards the institutional rules, regulations, and conventions that govern RF in these countries, as seen from an official legal-institutional perspective.

This chapter begins by examining the UK and France, looking at their rules and regulations from each of the countries' perspectives. The sections start with a general look at each particular approach to regulation, and then gradually the focus narrows to wireless communications. Each section introduces the main actors, describes the overall approach and summarises the regulatory framework. Based on the threshold tables of the RF section in the *Introduction* chapter (*human hazards* and *spurious emissions*), Europe (UK and France) is compared to the US from a social perspective and looking at risk tolerability; the regulation of short range devices and the acceptance of top-down technologies are contrasted. The indicators of each country are specified; comparative data of all countries appears in the *Indicators master-data* (see Appendix B). The ITU does not deal with military systems. However, the Defence forces use the RF spectrum extensively: radars, video for intelligence and tactical radio; the armies of UK, France and the US operate military wireless systems overseas. The protection of their wireless military systems and their RF reallocation therefore reveals also their attitudes to risk.

1 RF Regulatory Framework in the UK

1.1 Main Players in the UK

The **BERR** (Department for Business, Enterprise and Regulatory Reform[1]; formerly DTI) is the executive ministerial branch for Ofcom (Office of Communications). The BERR's objective is to maximise the effectiveness of collaboration both with the EU and internationally. The fact that responsibility for implementation of European Community

[1] The name reform is interesting. Ofcom initiates and implements many regulatory reforms; see later.

(EC) and World Trade Organisation (WTO) policies lies with a government department means that the BERR is responsible for their implementation, and not Ofcom. However, Ofcom represents the UK in ITU (except in plenipotentiaries) and CEPT.

The **Spectrum Strategy Committee**, of which Ofcom is a member, exercises overall control of the spectrum; it includes the allocation for military use, the single largest user of spectrum in the UK, managing around a third of the spectrum examined (Cave Audit 2005:47). The government has the power to give directions to Ofcom on specific matters, including national security, public safety and international relations. The government may also give directions on any other aspect of spectrum management, but such directions must be discussed and approved by Parliament.

Ofcom has taken over all the regulatory duties, functions and powers of the Radiocommunications Agency and four other existing regulatory bodies – the Office of Telecommunications (Oftel), the Radio Authority, the Independent Television Commission and the Broadcasting Standards Commission. Ofcom is the independent regulator and competition authority for the UK communications (both wired and wireless) industries, with responsibilities stretching across television, radio, telecommunications and wireless communications services. Its main regulatory roles and objectives are to secure the optimal use of the RF non-military spectrum in the interest of all users, and improve the overall framework for spectrum management. Ofcom promotes the interests of citizens and consumers through competition and market mechanisms. It has been suggested that 'Ofcom is one of the most forward-thinking bodies'[2].

1.2 The UK Overall Approach

In the past, the UK managed a unique regulation: “Before UK membership of the EU, no 'foreign' regulator oversaw Whitehall's activities” (Hood *et al.* 1999:72). After joining the EU: 'for Coordination the European Secretariat is established (located in the UK Cabinet Office), in the heart of the core executive' (Bender 1991:16; Dowding 1995 129-30). Today, UK (like other EU Member States) implements EU rules by statutory implementation (Hood *et al.* 1999:169). A significant part of the Communications Act 2003 is the UK's attempt to follow the EC regulatory framework. The new Directives replace the UK's old licensing regime with one of general authorisation to provide electronic communications (e-Communications) networks and services, coupled with general and specific conditions. The Act harmonises the UK spectrum-licensing regime with the EU Authorisation Directive and

[2] Rod Hall, Director of telecoms equity research at Dresdner Kleinwort Wassestein, 1/12/05. The UK is first ranked in Europe also by ECTA 'Regulatory Scorecards; http://www.telegeography.com/cu/article.php?article_id=15830l 19/12/ 07; see also Ofcom 2007a.:233, UK leading broadband penetration.

Framework Directive. The frequent changes in the UK telecommunications regulatory framework have been the result of the implementation of various EU directives.

'The governing political party dictates the legislation passed during their time - Tory governments focused on deregulation, flexibility … It may explain the assertive activities of Ofcom' (see the Commentary of Slater in Lofstedt and Vogel 2001:411). A key determinant of the UK wireless e-Communications is the RF strategy initiated by the government and implemented by Ofcom. The approach to spectrum management was an act of political will, driven from above not created from below; it was a government decision to pass the Communications Act and thereby provide the regulator with tools such as spectrum trading and liberalisation. It is motivated by a policy framework of favouring market mechanisms and deregulation. The UK Prime Minister's Strategy Unit (2002) defined the UK's 'light touch' regulatory behaviour toward risk as **'**where individuals or businesses impose risks on others, government's role is mainly as regulator, setting the rules of the game'.

RF spectrum control is carried out mainly by only one manned fixed monitoring station (Baldock in Hertfordshire) and 70 field officer cars, most equipped with measuring equipment. As Low As Reasonably Practicable (ALARP) is a fundamental concept in all fields of safety in Britain, and in particular in leisure safety (Health and Safety Commission 1996), and has been defined by the courts. The BBC is leading innovation in Europe, being the first to introduce practical TV (in 1926, one year before the American AT&T), FM radio (1955), NICAM[3] stereo digital sound in TV (1986) and digital TV (1998). From the moment that the Radio Agency became Ofcom (2003), UK became the leading administration in liberalising e-Communications. This may be explained by the economics-based worldview of Ofcom; the decision makers follow the economist's worldview[4], more than the technical regard of the engineers and the lawyers. The aim of serving the citizen-consumer guides its officials; Ofcom principal duty afforded to it under the Communications Act 2003 is to further the interests of (i) citizens in relation to communications matters and (ii) consumers in relevant markets, where appropriate by promoting competition. As outlined in the Communications Act 2003, Ofcom's first specific duty is to ensure 'the optimal use of the electro-magnetic spectrum'. A light-touch, open, non-discriminatory approach and transparent licensing are fundamental aspects of the Act, which aims to harmonise and simplify[5] licence rules and conditions wherever possible. The Wireless Telegraphy Acts exempt a large part of RF activity from the obligation of obtaining a licence. The UK's

[3] 'Near Instantaneous Companded Audio Multiplex' is a format for sound on analogue TV transmissions.
[4] Lord David Currie, the Ofcom chairman (till 31 July 2009) is a Professor of Business Economics.
[5] See Ofcom 2007b. *Simplification Plan: Reducing regulation and minimising administrative burdens*.

liberal attitude leads wireless regulation in Europe in secondary trading, implementation of digital TV, introduction of 'light touch' licensing (such as lifetime licensing service for ships' and amateur radio), with a technologically neutral format for spectrum auctions to facilitate liberalisation, and military spectrum release or sharing for commercial usage (Martin Cave Report 2002:39 and Cave Audit 2005:50). The UK also moves towards "service neutrality", to allow any service to be provided and in particular removing present restrictions on providing mobile services (rather than just fixed or nomadic access).

The UK is favoured by its geographical location: HF emissions may reach the various parts of its empire (Hills 2002:211); the UK is closer to America than Europe. Moreover, as an island the UK has an advantage over Europe and Africa in broadcasting AM radio transmissions near the shore: the propagation loss in Medium Frequencies (MF, 300 to 3 000 kHz) is smaller when the transmitting stations are located nearer the sea. The British Isles are not separated from Europe as far as RF is concerned: emissions below 3,000 MHz (MF, HF, VHF and UHF bands) cross the Channel to and from Europe thus causing interference. Therefore, the UK has to harmonise its RF with Europe in order to avoid mutual interference. However, the UK does try to maintain some RF distance from the continent and develop its independence; UK limits the European RF harmonisation when it conflicts with other interests; as stated in the Cave Report (2002:IV). In contrast to the currency or left-hand driving, RF is not perceived as a cultural item, so the UK has little problems in relinquishing some of its RF sovereignty in order to optimise wireless utilisation. The RF Spectrum is rationed logically. It seems that in UK the approach taken is that of 'interpretation' of the law[6], to refer to the spirit of the law and not the text itself; to see RF regulation as a tool, not an aim. The idea of 'interpretation' and not strictly following the law can be related to the *common law*, where the judge has relatively more discretion than the European judge under *civil law*.

The British established the services of general economic interest in their colonies: 'Plenty of good land and the liberty to manage their own affairs seem to be the two great causes of the prosperity of all new English colonies; the political institutions of the English colonies have been more favourable than French, Spanish and Portuguese' (Adam Smith 1776/1976:570). The British authority over its ex-colonies is stronger than the hegemony of Portugal, the Netherlands, Germany or Italy. The geopolitical influence of the UK's wireless standards is strong. The UK regulates its colonies; it has been said about the colonies that 'on the whole England's invisible exports were law and free trade' (Paterson 1993:121). The UK is a

[6] Based on oral discussions with an official of Ofcom, June 2004.

leading international regulator with the power to guide Europe, Africa, Asia and Australasia in these matters. Its influence is strong in English-speaking countries, British ex-colonies and in the Commonwealth countries. The Wireless Telegraph Act (WTA) in Israel (retaining the same name as in UK) is based on the 1949 British 'Mandatory' WTA. South Africa is another country influenced by UK RF regulations[7]. The UK was first to conduct formal Spectrum Reviews; this initiative was followed in Europe by the Detailed Spectrum Investigation (DSI) process; the European Table of Allocations is expanded in ITU-D Resolution 9 (on National RF tables).

The Indicators of UK

Basic country data, 2006: size (Km^2) 224,820, population (m) 60.5, GDP per capita (£) 21,322. The UK is the source of the *common law*, which is the legal origin of all English-speaking countries (see *Indicators* subsection 2.2.5, regarding Mauritius). Germany and UK were the first to apply the PAL colour TV system in 1967; PAL operation characterises the colonial inheritance and geopolitical influence of the UK (and Germany). The UK intends to implement the DVB-T technology between the years 2008 to 2012, region by region. UK is a Member State of CEPT, CTO[8] and EC. UK operates the UMTS 'third generation' cellular; in Britain, the public sector operates TETRA system under the name 'Airwave'; there is no use of CDMA2000. The most common religion is Protestant Anglican; the UK is unreligious; the mainstream view is that religion and politics should be separated.

The National Radiological Protection Board (NRPB[9]) (see NRPB 1993 volumes 4 and 5) power-density level of *human hazards* in the GSM900 band is higher 8.2(!) times than the ICNIRP (International Commission on Non-Ionizing Radiation Protection) and European threshold: 41 W/m^2 relative to 5 W/m^2; see the RF introductory section, table 5-7. The 1993 NRPB levels are still published on the WHO website. However, after intense media campaigns, the Stewart inquiry 2001 and 'NRPB 2004: Recommendation 131, p.28', the UK government has in fact agreed that emissions from cellular base stations should meet the *ICNIRP* guidelines for public exposure, 5 W/m^2 (at 1 GHz). Regarding magnetic fields, health risks from powerlines, the NRPB 1993 and current WHO website (30/12/07) indicate the magnetic H-field strength's value as 64,000/f (f in Hz) (= 1,280 A/m); 16,000 (!) higher than the ICNIRP and European threshold; the recent threshold 'NRPB 2004: Recommendation 102, p.21' is again the ICNIRP level, 4/f = 0.08 A/m, at 50 Hertz.

7 'South Africa especially in spectrum management, is trying to copy Europe, in particular the UK and other English-speaking countries, like Canada and New Zealand, and, in a certain way, the USA.'; a message to the author from a South African colleague, on 4 February 2004.

8 The Commonwealth Telecommunications Organisation (CTO)- an international development partnership.

9 NRPB was incorporated in the Health Protection Agency on 1April 05.

Summary of UK Regulatory Framework

The UK is a frontrunner in regulating wireless telecommunications. It is motivated by the approach of maximising the freedom of the individual. Britain applies a free market; UK is the main leader of the European liberalisation in e-Communications. UK applies and implements liberal recommendations (such as those in the Cave Report 2002) ahead of most of Europe. When there is any RF conflict placing Europe against UK and USA, the UK is part of Europe. UK influences European and global RF regulation towards liberalisation; this may be seen in the UK's contributions to ITU, CEPT and ETSI . UK is among the first to implement EU directives. However, in ITU World Radio Conferences (WRCs), UK may adhere to the US position. UK has merged the regulation of broadcasting and telecommunications: within broadcasting, content and transport was merged; within telecommunications, the fixed and wireless telephony was converged. UK is also leading new technologies in broadcasting video and sound.

2 RF Regulatory Framework in France

2.1 Main French Players

The Ministry Delegated for Industry is responsible for the French policy of e-Communications and information technology. The Minister in charge regulates telecommunications and ensures the international representation of France in this field. The additional bodies surrounding the minister are:

- DGE (*Direction Générale des Entreprises*) which prepares the government's policy positions on postal and telecommunications matters. The minister in charge of telecommunications grants operating licences for public networks and telephone services.

- CSSPPT (*Commission Supérieure du Service Public des Postes et Télécommunications*) is the inter-ministerial policy advisor, formed of the principal forces in the coalition and opposition parties, to promote telecommunication legislation. It is made up of seventeen members, appointed by the minister delegated to industry: seven deputies, seven senators and three qualified experts.

- The Ministry of Defence has significant input into any policy decisions that affect national security or defence. The late and restricted opening (relative to UK) of Wi-Fi (Wireless Fidelity standard) and RLANs[10] RF bands resulted from negotiations with the Ministry of Defence. The requirements of the French Defence ministry are on many occasions the cause

[10] Radio Local Area Network; identical to WLAN- Wireless Local Area Networks; similar to Wi-Fi.

of non-harmonisation of RF bands in the EU[11]. The national and international defence interests of France give rise to the different views on RF allocation in CEPT meetings.

- ANFR *Agence Nationale des Fréquences* is the National Frequency Agency, a public administrative organisation created to optimise the management of the RF spectrum. A board of directors from government administrations, the CSA and ARCEP (see below), manages the ANFR. ANFR cooperates with ARCEP by subcontracting projects. The nine (7+2) *affectataires* participate in ANFR consulting commissions. With more than 350 employees ANFR is one of the most dominant bodies in the Radio regulation of Europe and ITU; its main emphasis is on engineering.

- ARCEP *Autorité de Régulation des Communications Electroniques et des Postes* is the e-Communications and posts Regulatory Authority, an independent administrative authority regulating e-Communications, jointly with the minister in charge of telecommunications. ARCEP has its own budget financed by public funds, voted by Parliament; fees and taxes are paid to the general budget, not directly to the Authority. ARCEP combines wired and wireless e-Communications. ARCEP applies all the legal, economic and technical provisions to enable its activities. It encourages a market-based policy, and co-operates within the European 'Independent Regulators Group' (IRG) and European Regulators Group (ERG).

- CSA (*Conseil Supérieur de l'Audiovisuel*) regulates the broadcasting sound-video sector (TV, radio, cable TV): content and transport. It exercises the freedom of broadcasting through political pluralism. CSA utilises most of the civil RF spectrum for terrestrial and satellite broadcasting. CSA covers the broadcast content, whereas frequencies are allotted by ARCEP to CSA, which then assigns them to operators. CSA issues broadcasting licences to FM radio stations and private television companies. The French broadcasting regulation is different to that of the UK and the US, where the broadcasting is managed by the same organisation (Ofcom in the UK or FCC in the US), as all with other e-Communications services (wired and wireless).

- CCR (*Commission Consultative des Radiocommunications*) is the Advisory Panel on Radio Communications. It is composed of twenty-one members[12] appointed by order of the Minister in charge of telecommunications, following consultations with the ARCEP.

- CCRST (*Commission Consultative des Réseaux et Services de Télécommunications*) is a parallel panel to CCR, advising on wireline communications and services[13].

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[11] The harmonisation of RLAN at 5 GHz was delayed in Europe, mainly due to France.

[12] Seven representatives of the radio network operators and service providers, seven representatives of the professional and private users of these networks and services, and seven qualified experts.

[13] UK, USA and EU are different; they converge the wireless and wire activities.

A two-level system: RF Allocation and Assignment

France implements a dual-level RF framework: allocation by ANFR proposals, and assignment by separate authorities. There is no one office in France, like Ofcom in UK, with a responsibility for all non-military RF. Seven government[14] departments/ agencies share the RF spectrum (known as *affectataires*, as they are affected) and assign RF for government usage. Two independent authorities (two additional *affectataires*) license and assign RF for non-government usage. ARCEP assigns RF for telecommunications (mobile and fixed services) and CSA for broadcasting; see *Table 2-1*.

Table 2-1 A dual-level Allocation and Assignment system[15]

France	Spectrum used by Government Agencies	Spectrum used for telecoms and feeder links to broadcasting	Spectrum used for broadcasting
Authority allocating frequencies	The Prime Minister approves the national RF allocation table submitted by ANFR (after consulting ARCEP and CSA)		
Authority assigning frequencies	Government Agencies: 7 *Affectataires*	ARCEP assigns to the telecom operators	CSA assigns to the broadcasters

2.2 The French Overall Approach

"The French '*grand corps'* is one well-established way of cementing a grouping into a group" (Hood *et al.* 1999:213). France innovated technological spectaculars of '*nouvelles cathédrales*' (Crane 1979:39), such as the SECAM TV standard and the Minitel. The French 'cathedral' will be compared later to the US 'bazaar'. French citizens have a high degree of trust in their government (Slovic 2000:324). France is a market-based economy, like all developed countries; however, it is differently styled due to its centralised policy. France as a single state has a long history also in European terms. The roots of French centralism can be found in the year 1210, at the time of Philippe Auguste and later, during the Jacobins' battle with the Royalists administration. France is governed by a strong centralised administration. The separation of power also has historical roots; after the king Louis XIV ("*l'état c'est moi*", "the state is me"), Montesquieu's separation of the three administrative authorities has been the example for modern regimes. The French centralism is not inconsistent with the division of power. France follows the doctrine of 'interdependency and not absolutism' (Hall, Scott and Hood 2000:8), and distributes power among several institutions. France is typical of the Catholic 'collective' worldview. However, 'France embraces modern Catholicism' (Weber 1904-5/1947:124); in France the church is separated from the state; this

[14] Defence, Interior, the *Centre National d'Etudes Spatiales* (CNES), Meteorology, Civil Aviation, Ports and Maritime Navigation, and Radio Astronomy.

[15] The draft was provided to the author by Mr. Rolfo Dominique-Jeanan of ANFR, on 11 May 2004.

separation was instituted by law on 9 December 1905. Secularism is more typical to France[16]: religion is segregated from matters of governance. Nevertheless, Catholicism spirit may be reflected in the French 'central-planning' approach in wireless regulation.

There is no convergence of wire and wireless telephony, or broadcasting and telecommunications; however, under CSA the transport and content of broadcasting are merged. There is an influence of French centralism on the EU current regulation. France offers a collectivist policy, an egalitarian agenda, a welfare state advocating Majoritarianism; the government may restrict individual freedom, if a presumed majority of the community wants to do; 'power in the hands of the greatest number' the Thucydidean[17] worldview. The French State tends to be a much stronger and centralised regulator than the UK, for ideological/philosophical reasons; compared to UK, there might be a greater state control of water and electricity. Contrary to the UK view, France considers that the EC should be more than a single market, and should be extended to other societal domains.

In France, 'Public' generally means that it belongs to the state. Radio spectrum is clearly defined as a public property belonging to the State. Under French law, state property cannot be sold or alienated. The State has the obligation to maintain its domain and, according to the ITU Radio Regulations, to use it efficiently. Laws define rules on occupation of public property of the state, and these laws are the basis for authorisation of use by operators. The property rights for the use of spectrum are derived from the status of that public property (see CEPT ECC 2005:74). Property rights define the position of France toward Spectrum trading, since it means that only the French government can consider trading rights of use of spectrum. The RF spectrum control is carried out by 57 monitoring stations which are centrally controlled from Villejuif; compared to other countries, this is significant evidence of the French 'command and control'.

France has actually no real RF barriers at its borders. Radio emissions from its adjacent neighbours (Belgium, Germany, Switzerland, Italy, Andorra and Spain) below 30 GHz (especially the MF, HF, VHF, UHF and SHF bands) propagate into France. Wireless equipment crosses the borders with practically no inspection; harmonised European RF is therefore vital for French interests. Additionally, France does not perceive the national RF management as a cultural issue, unlike the French language or Napoleonic code (*civil law*). France is active in expanding its culture, regulatory framework and wireless standards mainly in French-speaking countries.

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[16] Relative to conservative Catholic countries, where the Church is more involved in state issues; see Ecuador *case study*.

[17] Thucydide is cited in the preamble of the 'Draft Treaty establishing a Constitution for Europe'.

La Porta, Lopez-De-Silanes, Shleifer and Vishny (1999, cited in 'Lex Mundi Project' Djankov *et al.* 2003:487) argue that the transplantation of French legal rules is conducive to general state interventionism and bureaucratic inefficiency. The French *civil law* is the legal origin of most countries where the language spoken is French, Spanish or Portuguese (mostly Catholic countries, see *Indicators* chapter); it is practiced also in the State of Louisiana in the US and Quebec in Canada. The French authority and traditional influence on its ex-colonies remains strong. The geopolitical influence of the French regulatory framework and wireless standards (like the SECAM colour TV standard) are durable, in comparison to Spain's influence on Latin America.

The Indicators of France

Basic country data, 2006: size (Km^2) 545,630, population (m) 62.8, GDP per capita (£) 19,242. Most of the population is Roman Catholic (about 85%). France invented and applies SECAM colour TV. Francophonie reflects the French historical glory, its colonial heritance and the present geopolitical influence. French-speaking countries operate SECAM and apply 50 Hertz mains electricity (and drive on the right-hand side). France will end the over-the-air analogue TV broadcasts in November 2011, starting DVB-T broadcasts from mid 2008 (as declared by President Chirac). France is a Member of CAPTEF (Administrative Conference of Posts and Telecoms of French-speaking countries), CEPT, EU and FRATEL (Francophone Telecoms Regulatory Network). France operates UMTS and TETRA technologies; the police system is known as 'TETRAPOL'. The official levels of *human hazards* in the cellular bands are the International (ICNIRP) and European threshold levels.

Summary of French Regulatory Framework

France is a leading European Regulator. It is centralised. The power is split between ANFR for RF allocation on the one hand, and ARCEP, CSA and other national bodies for RF licensing and assignments, on the other hand. ARCEP is also responsible for wired e-Communications. ANFR and ARCEP are active both in international and European regulation. ANFR is technically oriented; it has an authoritative view and leads engineering and administrative issues in the ITU-R and European RF allocation. Regarding RF regulation, France is more top-down in its RF decisions than UK (and USA). In ITU Radio Conferences, France in many cases leads the European position against certain American interests[18]. As a leader in EU and in harmonising the European RF, France follows and implements EU regulation in RF allocation. ANFR and ARCEP influence EU and then formulate the decisions in France. France did not unify its regulation of broadcasting and e-

[18] Examples: WRC03- Galileo RF Allocations versus GPS, WRC1995- allocations to satellite radio navigation.

Communications, unlike the UK (and USA). In addition to its EU and CEPT activities, France functions also at a global level, to realise its worldview, its historical role in Francophone countries, its global defence politics and the needs of its colonies.

3 RF Regulatory Framework in the US

3.1 Main Players in the US

Law and Regulation

The Congress, Federal Courts and the states form the legal framework of communications; see Bruce and Cunard 1986:165.

Congress: It created the FCC and adopted the Communications Act. Congress can alter communications law (through new legislation) and policy (by exercising its power over the FCC). Congress can override FCC decisions by legislation, or delaying FCC action. The opinions of Congressmen have a persuasive effect on the FCC. Congress influences the telecommunications regulation via its committees and through the funding/ appropriations process: the American government runs an economy which is highly protectionist towards domestic industry; it is a decentralised country, in which producer pressure can be easily and effectively levelled at Congress (Hills 1984: 245).

Federal Courts: The US Court of Appeals may review the FCC decisions; the courts decide if the FCC has acted within its delegated authority. Courts ensure the rights of individuals; activist judges may set policies, thus usurping the decision-making powers.

States: The states have a number of powers that are explicit in the Act. They exercise control of intrastate communication services, through state utility commissions, which are regulatory agencies. Their courts review decisions of state agencies, as the federal courts review the FCC decisions.

NTIA- National Telecommunications and Information Administration

The NTIA is an agency of the US Department of Commerce; it is the executive on domestic and international telecommunications, and information technology issues. NTIA works to spur innovation, encourage competition, help create jobs and provide consumers with more choices and better quality telecommunications products and services at lower prices. The basic function of the NTIA's IRAC[19] is to assist in assigning frequencies to the US Government radio stations and in developing and executing policies, programs, procedures, and technical criteria pertaining to the allocation, management and use of the RF spectrum.

[19] Inter-department Radio Advisory Committee (IRAC) is chaired by the NTIA.

FCC- Federal Communications Commission

FCC is an independent US government agency, directly answerable to Congress. The FCC was established by the Communications Act of 1934 and is charged with regulating interstate and international communications by radio, television, wire, satellite and cable. The FCC's jurisdiction covers the 50 states, the District of Columbia and US possessions. FCC manifests itself in four powers: Rule-making, Directing, Investigatory and Licensing. The FCC only operates on a federal level; the RF Spectrum is regulated at a federal level. FCC is an international leading commission in setting up regulations; being influential mainly in North America, South America and Asia. Its activities are well coordinated with industry. FCC has for 70 years led market-based policies for RF spectrum-based services, to create a flexible regulatory environment hospitable to innovation. FCC places strong emphasis on property rights and unlicensed "commons". Most of the FCC personnel are lawyers and engineers[20], in contrast to Ofcom (economic motivation) and ANFR (engineers are dominant).

FCC Type Approvals: Part 2 of the FCC 47CFR (Code of Federal Regulations) regulates the US's type approval process in order to ensure that telecommunications equipment complies with the appropriate technical standards and FCC rules. The kinds of type approval listed according to the rate of growth are: verification (47CFR§2.902), a self-approval procedure; declaration of conformity (47CFR§2.906), a self-approval process; and certification (47CFR§2.907), an approval process requiring that the responsible party submits an application for review and approval. Even a garage door opener needs the FCC certification; the FCC-marking is affixed in these devices. The type approvals enable the FCC to be more tolerant in the *spurious emissions* levels, as it controls and can modify the RF characteristics.

State Department

In international meetings of treaty organisations the State Department leads the US delegations and coordinates the FCC and NTIA. The US Department of State, Bureau of Economic and Business Affairs, International Communication and Information Policy (CIP) group is one of seven issue-oriented organisations within the Bureau of Economic and Business Affairs at the US Department of State. CIP's primary goals are to negotiate the allocation of adequate RF resources for current and future technologies with organisations such as ITU; to advocate the acceptance of a variety of technical standards, including the US standards, so that the global market can choose the best technologies; and to advocate the

[20] A message from FCC, 28 Aug. 05: “here are about 2,020 people at the FCC in total. About 500 are engineers, about 500 are advocates, about 200 are economists, about 100 are public service specialists, about 200 are technical specialists, and the rest are administrative. All four of the FCC Commissioners are advocates

elimination of unnecessary regulations overseas and the privatisation of state owned firms. The US ITAC (International Telecommunication Advisory Committee) advises the Department of State in the preparation of US positions for meetings of international treaty organisations. The international meetings addressed by the ITAC are those of the ITU, CITEL (Inter-American Telecommunication Commission), OECD (Organisation for Economic Co-operation and Development) and APEC (Asia-Pacific Economic Cooperation). Members of the ITAC are drawn from the government, network operators, service providers, and manufacturers involved in the telecommunications sector; the ITAC is however also open to any US citizen.

Industry

The TIA (Telecommunications Industry Association) develops standards, such as cellular TIA-95 (CDMA or cdmaOne), TIA-136 (TDMA) and TIA-2000 (CDMA2000). Service providers such as the Cellular Telecommunications and Internet Association (CTIA) shape standards and regulation in the US. In USA the industry is the source of standards; it heavily influences the regulation (much more than in France). The US promotes RF industry innovation and 'Pioneers Preference', by assigning RF band to innovators with minimum regulation. The US industry launched the new concepts of Non-GSO satellite GPS; the promotion of SDR (Software Defined Radios)[21] and UWB (Ultra Wide Band)[22] devices are examples of the introduction of new technologies, industry's pioneering work, values of ownership and cooperation between industry and regulator.

3.2 The US Overall Approach

In the US, the founding fathers enshrined a principle of individual rights and freedoms. Through zealous protection of individual rights, coupled with civil litigation to safeguard against corporate abuses, the US model provides protection to its citizens. The Telecommunications Act of 1996 reflects the American approach to business: market-driven, deregulation and light touch. The US opens doors for individuals to participate in the regulation and standardisation processes. A legal perspective dominates the regulatory environment in the US: courts review regulatory decisions on procedural grounds, as they are often unable to examine the substance of a decision's analytical content (Morgan and Henrion 1990:293-4). The US possesses a competent regulatory framework; the FCC and NTIA share responsibility for managing the spectrum. NTIA manages spectrum used by the

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and there is one vacancy awaiting nomination and confirmation by the political process.".

[21] SDRs can change the frequency range, modulation type, or output power of a radio device without making changes to hardware components.

[22] UWB operates at such low power that pre-existing users of the same spectrum bands won't even know the

Federal government (such as air traffic control and national defence); FCC is responsible for spectrum used by others, including individuals (for example, Wi-Fi and Bluetooth), private organisations (such as cellular operators, radio and television broadcasters), and public safety and health officials (like police and emergency medical technicians). There is a lot of common spectrum which is shared and managed both by NTIA and FCC for government and commercial services. The third player in the US RF regulatory framework is the most important in international issues - the State Department. The US RF law and policy involves a complex combination of state, federal and local authorities.

As the US is well interconnected by cables, the cellular penetration is relatively low in the US (relative to Europe). As a consequence, Europe is leading the cellular market, and there has been less necessity to transmit TV signals to mobile handset in the US. In the US 'the people are the sovereign and the ultimate source of political legitimacy' (Altman 2001:91); Abraham Lincoln's 'Gettysburg Address'[23] states to whom the sovereignty in the US belongs: "Government of the people, by the people, for the people". RF spectrum should be used much more to provide more utility to the society: economy, working places and safety of life. The US telegraph, broadcasting and telecommunications services were never nationalised. Slovic (2000:324) states that Americans combine their distrust of government, science and industry; however, the US citizens are obedient and do trust science and promote their industry. The US is different from Europe: the US is a large, diffuse society, with an absence of a widely read national press and regional power distribution. Since 1920 broadcasting stations have been operated exclusively by private operating companies. Therefore, the 'social amplification' in the US is more difficult to achieve; it is easier to spread fears of risk at a national level in Europe.

In general the US preceded Europe in developing wireless technologies: for example, the analogue cellular AMPS, the colour TV NTSC, the digital TV ATSC, the digital cellular CDMA, SDR, UWB and BPL (Broadband Power Lines). As a result the North American consumers (and others who adopt the US standards) have enjoyed early wireless services. When Europe follows, superior results can be obtained in view of the experience gained, allowing Europe to offer more advanced standards (PAL/SECAM, DVB-T and GSM). The US pushes forward with standards which are not fully defined, leaving certain elements open to competitive forces; the result is a shorter time to market (such as the CDMA); however, inter-operability are sacrificed to a certain degree. On the other hand, in Europe the approach is to develop complete standards to gain harmonisation and uniformity (such as the GSM).

UWB transmissions are there; it is the core technology for home entertainment networks.

[23] Lincoln 19/11/1863; to be compared to Thucydide definition 'power in the hands of the greatest number'.

The Telecommunications Act of 1996 is one of many examples of the American approach to business and to the individual. The US government often paves the way for the private sector to flexibly utilise the radio frequency spectrum, even in areas that are not yet approved in the ITU-R: such as RLAN, Satellite compatibility with unlicensed electronic devices and UWB (Ultra Wide Band) devices. The FCC wireless rules are less restrictive than the European; this could be explained by the differences in population density, and the technical (non-administrative) solution by the industry in the crowded cities. Despite liberalisation efforts thus far by the FCC, the General Accounting Office (GAO) 2004 report recommended to further redefine the RF allocation system, in order to build in greater flexibility.

As a superpower the US' authority is strong, mainly outside Europe. The US' wireless standards and rules are widespread; they are most conclusive in Canada and Mexico, strong in South America, the Middle East (Israel, Jordan, Egypt and Saudi Arabia), Asia, Australasia and competes with European RF standards in Africa. The third cellular generation CDMA2000 remains backwardly compatible with the older CDMA telephony method (cdmaOne, the TIA-95). However this is not the case with the (European) incompatibility of UMTS with GSM. Today, The CDMA policy reflects the highly competitive and influential US marketplace and the need to retain customer satisfaction in a forward-looking mode.

The Indicators of the US

Basic country data, 2006: size (Km^2) 9,158,960, population (m) 297, GDP per capita (£) 24,017. Most of the population is Protestant 52%, 24% is Roman Catholic. Eighty VHF/UHF monitoring stations carry out the RF spectrum control in the US. The US implements the *common law* and applies 60 Hz mains electricity. The US was the first to broadcast TV in colour in 1954 (NTSC), 13 years before France, Germany and UK. Countries applying 60 Hz and driving on the right-hand side mainly operate the NTSC system (such as Philippines, South Korea, Taiwan), versus 50 Hz and left-hand driving countries (Thailand, Singapore, Australia, India) operating the PAL system. Using the US international dialling code +1 and the CDMA2000 technology (versus UMTS) also reflects the US influence. The US is already implementing the digital TV standard (ATSC) and will end the over-the-air analogue TV broadcasts on 18 February 2009; since 1 March 2007 analogue-only TVs cannot be sold in the US. Regarding communications, in addition to the ITU, the US is a Member of CITEL and NAFTA (North America Free Trade Agreement). While Canada and Mexico generally harmonise with the Americans, this is not the case around the world. The official levels (31 December 2007) of *human hazards* in the cellular bands are less restrictive, 4/3 of the International (ICNIRP) threshold.

Most of the world operates Calling Party Pays (CPP), whereas in the US and Canada the cellular Receiving Party Pays (RPP). Lack of CPP and superior wireline telephone services may explain the relatively low cellular penetration in the US and Canada, with respect to the average income. Based on the ITU-D data of 2006 from 169 countries (see Appendix B), Figure 3-1 depicts the internet versus the cellular penetration; it highlights the outlined countries and the *case studies* in the research. Moreover, it is another explanation of the European GSM success: less penetration of cellular (and the US standards) in the US and Canada causes less dominance of the US technology.

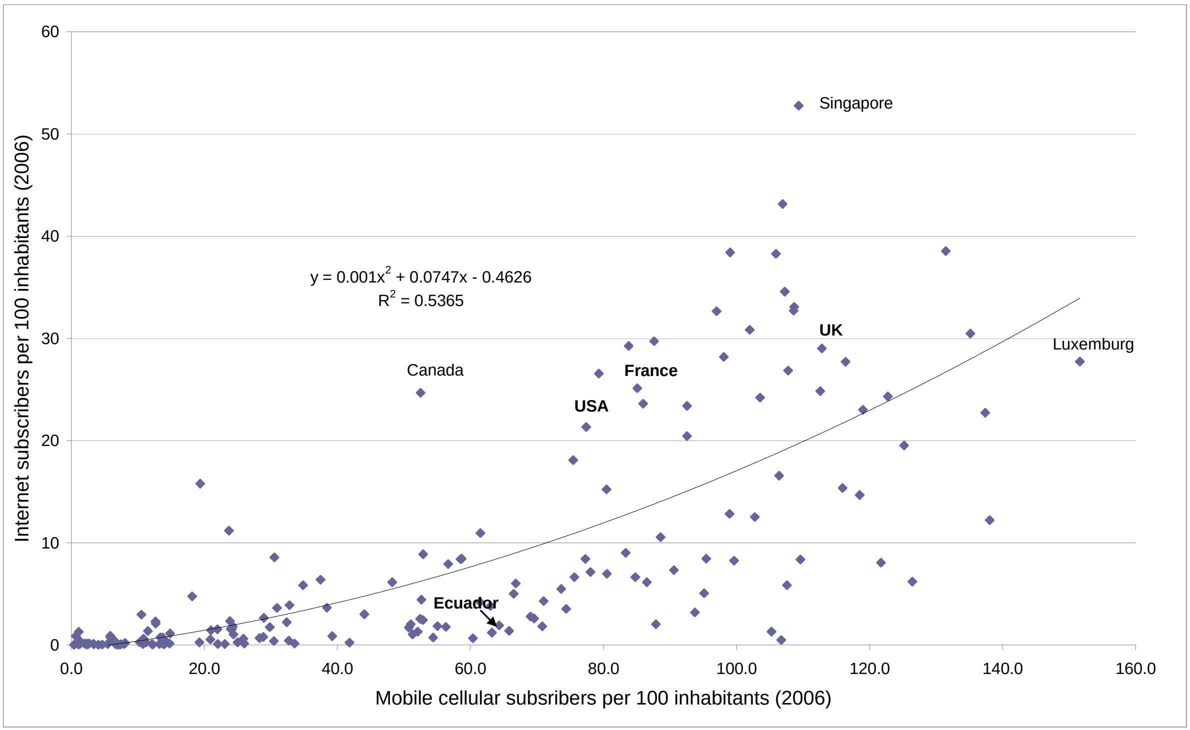

Figure 3-1 Internet versus Cellular Penetration (2006)

Summary US Regulatory Framework

The US society '…was historically and culturally more individualized and less bound by historical identities and class contestation' (Burgess 2006:334). Isolated by oceans from Europe and Asia with respect to RF spectrum[24], bigger in size and in population than any European country, USA developed its independent policy. Property ownership in the US is absolute 'from core of earth through space'. The telecommunications infrastructure and airwaves belong to the public. The US regulatory framework is more stable compared to that of the UK and France. For many years in the 20th century, the US served as a lighthouse for wireless regulators in Europe and other developed countries through transparency, light touch, liberalisation, market-mechanism and public consultation. Moreover, RF spectrum is

24 Excluding Satellite and HF communications, that may cause mutual interference.

viewed as a common good (e.g. Licence Exempt), and innovation is essential in its management. The radio spectrum allocation process is effective. The US regulatory framework is unique: policy-making and rule-making are shared between NTIA and FCC. The NTIA regulates the government users; the FCC rules the non-government users. Most of the overall spectrum policy is determined through negotiation between both agencies. At an international level, most of the proposals are jointly developed by NTIA and FCC; the State Department represents the US at international conferences. Industry is the booster of the US wireless regulation and standards. FCC assists the US industry, as part of the general support of the Administration to business. The wireless regulatory framework of the US fits the US entrepreneur worldview. The US regulation and RF standards have an influence on Canada, Latin America and worldwide; EU conducts an independent RF policy and competes with the US. New technologies, more License exempt RF and Software Defined Radios may revise the future role of the FCC.

4 RF Regulatory Framework in Ecuador

4.1 Main Ecuadorian Players

Figure 4-1 illustrates the key players in Ecuador's e-Communications arena and the clear separation between Regulation and Control, dictated by Articles 1 to 7 of the Special Ecuadorian Telecommunications Law.

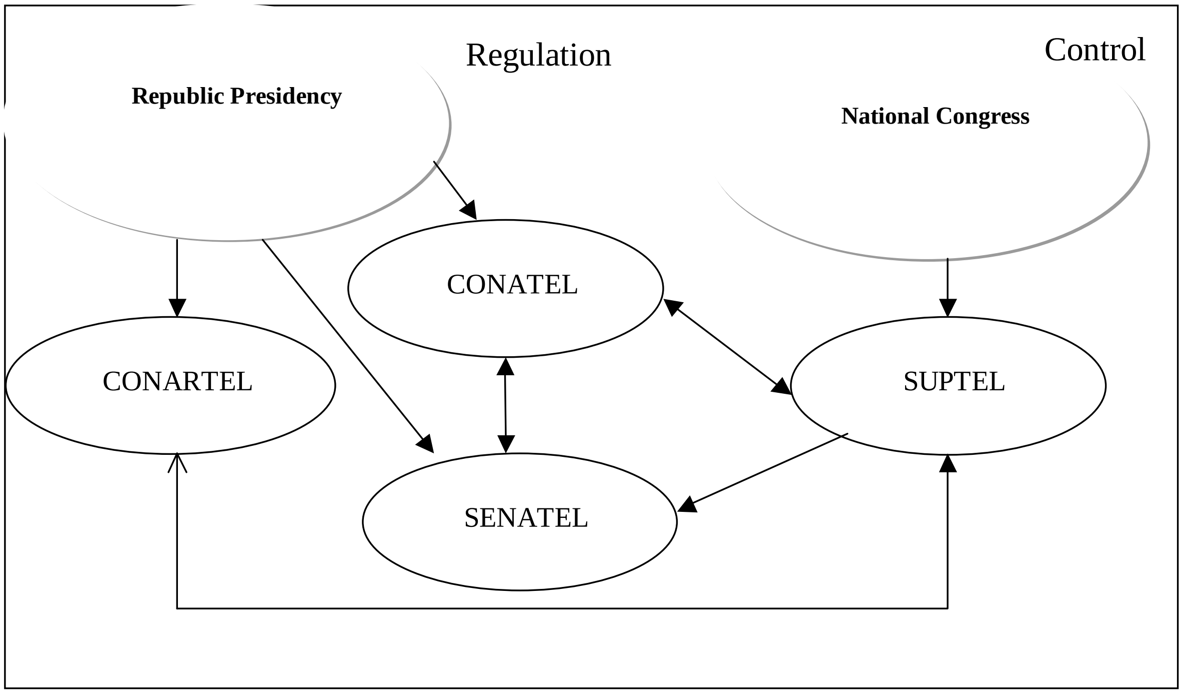

Figure 4-1 Ecuador e-Communications: Regulation versus Control

CONATEL (*Consejo Nacional de Telecomunicaciones*), the National Council of Telecommunications, is the policy maker in telecommunications and represents Ecuador in the ITU and *CAN*. CONATEL approves the national programmes for telecommunications, tariffs, RF allocation plan and usage. It establishes terms and conditions for the use of radio frequencies and the authorisation of the telecommunications services. CONATEL authorises SENATEL (*Secretaría Nacional de Telecomunicaciones*) to contract and license service provisions, network interconnect and RF usage. CONATEL approves SENATEL's working plan, and approves the budgets of both SENATEL and SUPTEL. The chairman of CONATEL is appointed by the President and is responsible for all wireless communications and the RF spectrum, including the military; CONATEL is not responsible for RF broadcasting. SUPTEL (*SUPerintendencia de TELecomunicaciones*) is the telecom supervisory body. The mission of SUPTEL is to control (both administratively and technically) telecommunications and broadcasting (sound and TV) services. SUPTEL executes CONATEL and CONARTEL's resolutions. SUPTEL applies the mechanisms to permit free competition in the telecommunications market. It surveys and controls the service providers and maintains a complete list of concession-holders. SUPTEL is responsible technically for the type approvals and tariffs that CONATEL approves. SUPTEL develops the technical infrastructure to control the RF spectrum: management, monitoring and enforcement.

SENATEL is the National Secretary of Telecommunications. Its chairman is appointed by the President of the Republic, and serves a 4-year term in this position. SENATEL provides policies for CONATEL and is responsible also for preparing homologation rules, and means of control of equipment and services, for CONATEL approval.

CONARTEL (*Consejo Nacional de Radiodifusión y Televisión*) is an independent organisation composed of the delegates of the President of the Republic (as its chairman), the Minister of Education and Culture and the Joint Armed Forces. CONARTEL approves the national allocation and assignment plan for broadcasting. CONARTEL is held responsible for the content of the radio and TV broadcasting programs regarding 'art, culture and moral'. It determines the policy for SUPTEL, when representing broadcasting in national and international organisations. The law indicates that the broadcasting (radio and television) frequencies will be granted through a concessionary contract. AER (*Asociación Ecuatoriana de Radiofusión*) is the Ecuadorian Radio Broadcasting association - the broadcaster of sound; AECTV (*Asociación Ecuatoriana de Canales de Televisión*) is the Ecuadorian TV channels association. One person in CONARTEL represents AER and another represents AECTV.

4.2 Ecuador's Overall Approach

The numerous reforms[25] in the Special Telecommunications Law (*LET*) highlight its flexibility during its early years. The *LET* legalises the installation, operation, use and development of transmission and reception of signals, images, sounds, data, optical information of any nature, by cable or wireless means. It defines the RF spectrum as a natural resource, an exclusive property of the state; therefore the RF spectrum management, administration and control is executed by the state, which is the RF proprietor of all rights. RF auctions have not been applied yet. According to Article 27 of the law, the public services (such as local and international telephony) have priority over all the other telecommunications services in obtaining rights, including the use of the RF spectrum.

The Ecuadorian telecommunications regulatory framework is influenced mainly by the US, as they are located in the same ITU Region 2, for RF allocations. For example: Ecuador follows the US 'Part 15', e.g. the CFR47§15.247 for Licence Exempt devices, and it adopted the US multi-media distribution systems (MMDS). The French collectivised top-down approach is also influent. Since 1830 Ecuador has followed the Napoleonic code (*civil law*), like other *CAN* and Latin American countries. Ecuador follows the philosophy of the French *civil law* and not the UK-USA *common law*; this is depicted in their manner of solving conflicts, in their consumer and property (civil) rights. The separation of policy formulation/ regulation (by the president) and control (by congress) may be also rooted in the French power separation (as with Montesquieu).

Ecuador, like all *CAN* countries is a Member State of these international telecommunications organisations (see *International and Regional* chapter): CAATEL, CITEL, REGULATEL and ITU; CONATEL represents Ecuador in these organisations. Ecuador officially follows the regulations and standards of the ITU. Ecuador is not leading the Andean Community (*CAN*) in the liberalisation of communications. Bolivia (a landlocked state) and Ecuador receive preferential treatment in *CAN*; see *CAN* Decisions 462 and 563: ‘Ecuador will notify later the liberalisation of communications services’, as anticipated in *CAN* Decision 439. There is no convergence in the regulation of telecommunications (CONATEL) and broadcasting (CONARTEL), which are separated by law.

The RF regulatory framework is derived from a centralised worldview of a ‘correct and rational’ RF planning[26]. The proliferation of actors complicates the regulatory framework and the rational RF allocation and licensing. Apparently, there is no convergence of

[25] Law No.184- *Registro Oficial* (*RO*) No. 996,10/8/1992; Law 94–*RO* 770, 30/8/1995; Law -*RO* S-15, 30/8/1996; Law 15 *RO* 31/7/1997; Law 17 *RO* S-134, 20/8/1997; Law 2000-4 *RO* S-34, 13/3/ 2000.

regulators (as opposed to the UK). The regulation of telecommunications and RF is complex. The implementation of any resolution is lengthy, as many organisations are involved in the process of approval; for example Article 131 of the law enables SENATEL to reallocate the RF bands; however SENATEL needs the approval of CONATEL to do so. Another problem is that the RF knowledge and experience in Ecuador is dispersed among different experts. The struggle between CONATEL and CONARTEL about the national RF plan is an example of the efficiency of one merged agency for telecommunications and broadcasting (as Ofcom and FCC). Ecuador considers a new law, to associate CONATEL, CONARTEL and SENATEL under one Telecommunications ministry. The separation of broadcasting (content and infrastructure by CONARTEL) from all other civil and military services emphasises the political handling of broadcasting in collectivised Ecuador.

The annual report of the World Bank in 1991 promoted liberalisation and the privatisation of the fixed network operator, EMETEL. The World Bank offered economic financing in return for Ecuador's commitment to privatise EMETEL. Actually, Ecuador lost most of the 1990s in the EMETEL privatisation failure, due to regulatory restrictions; it is an example of 'command and control' ineffective intervention.

Specific resolutions regulate the Type Approval process. SUPTEL is responsible for homologating wired and wireless terminal equipment. Type approval is required for every piece of wireless equipment. The international certifications and standards are obligatory in order to bring the equipment to market. FCC approvals and occasionally 'CE' markings can be accepted. There is a need for certification of technical parameters by a laboratory recognised by SUPTEL. The importer should ensure the provision of appropriate maintenance. The type approval is specific to the producer, importer and proprietor; otherwise the process is similar to that of the US. Ecuador does not license wireless receivers, like developed countries.

The introduction of analogue colour TV (US standard NTSC) in Ecuador is typical to other countries in the western part of South America. The introduction of black and white TV was promoted by HCJB[27], a North American missionary broadcasting station. In 1956 a license was requested, and in 1961 Black and white TV transmissions (Channel 4) were launched applying the US standard; on 20 July 1969 (first in South America) *Teleamazonas* TV covers the US moon landing in colour TV broadcast.

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[26] The *LET* specifies explicitly that 'Ecuador should use correctly and rationally the RF spectrum'.

The Indicators of Ecuador

Basic country data: size (Km^2) 276,840; population (m) 13,755,680 (July 2007 est.), GDP per capita $4,500 (2006 est.) (from CIA factbook). Ecuador is a Tropical country as the Equator cuts across its land. Ecuador is homogeneous regarding language (Spanish) and religion (Catholic- 95% of the population); Ecuador implements the *civil law*. Ecuador is a developing country. It applies 60 Hz electricity. No decisions have yet been taken regarding the digital TV standard and the end of broadcasts of the over-the-air analogue TV. The official limits for EMF *human hazards* are the ICNIRP threshold levels; see *Resolucion* 01-01-CONATEL-2005. On 31 December 2007 the most common cellular standard is GSM (operated by Porta and Telecsa); in addition to the European TETRA and DECT land-mobile standards, the US (AMPS, NAMPS, TIA-136, CDMA2000 and PCS1900) cellular standards are operational. Ecuador uses the US dollar as the only valid currency[28].

Summary on Ecuador Wireless Regulation

Ecuador is one of the 160 developing countries among the 191 Member States of the ITU. It is misleading to expect that a beneficial organisation of one society will yield the same results in another (Greif 1994:944). Ecuador does not pursue the regulation of other country; Ecuador applies an independent regulatory framework. Small countries are anxious about their sovereignty; moreover, any loss of sovereignty can be easily understood in South America as a new form of the "Gringo" US imperialism. RF independency in regulation and standardisation is also motivated by the desire to maintain power, honour, dignity, control and clerical employment (avoiding union dissent). It seems that mainly developed countries whose economies have been centralised for centuries (like France, UK and Germany) and suffered the horrors of World War II can afford to concede some of their sovereignty. Ecuador is an interesting *case study*, as it is:

1. Similar to other developing countries in South America and Asia, as regards the competing influence of US and EU.
2. Typical in culture of poor tropical countries such as Thailand and Philippines, not including the tropical success stories of Singapore and Hong-Kong, Taiwan, Malaysia and Mauritius (see Sachs 2001:9,26).
3. Ex-colony of Spain, as most Latin American countries; to be contrasted with other tropical ex-colonies such as Liberia (ex-colony of the UK), Angola (Portugal), Senegal (France) and Philippines (USA).

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[27] *Hoy Cristo Jesus Bendice*; their first HF emissions (1931) were in Ecuador.

[28] Theoretically, as in Ecuador the official currency is the US Dollar, a 'rational' regulatory step would be to 'climb atop the shoulders of giants': to adopt the US Code of Federal Regulations CFR47, or Canada's ‘Statutes

4. Similar to other equatorial countries[29].
5. A second country from the American Hemisphere (the other is the US), to balance the two European *case studies* (UK and France).
6. Typical of other Latin American states in culture and geography.
7. Similar to most countries that do not develop technologies and do not manufacture their own radiocommunications equipment; international manufacturers do not tailor equipment specifically for these relatively small markets.
8. Influenced by international organisations such as the World Bank, IMF (International Monetary Funds), IFC (International Finance Corporation) and WTO, toward liberalisation (e.g. privatisation and deregulation).
9. Influenced by globalisation.

In the last decade Ecuador has advanced toward privatisation of the e-Communications markets and other fields of general economic interest. Ecuador, like other developing countries, confronts the dilemma of whether to have a free wireless market in e-Communications, or to conserve its sovereignty, national framework and resist modern uniformity and globalisation.

It may be found that diverse cultures are better than one efficient harmonisation. Culture must be factored into the 'rational' regulatory framework. *Bounded Rationality* and *Rational Field Theory* may elucidate the difference between the present regulatory framework in Ecuador and other frameworks.

5 Synthesis, Compare and Contrast among *Case Studies*

The UK and France have found the EU directives to be useful on a national level, and therefore follow them; the consequence is that the UK and France regulate the RF spectrum in similar ways, and adopt the same RF standards. UK (like the US FCC) converged all e-Communications (wired and wireless) and broadcasting under Ofcom; France separates power and RF assignments among ARCEP, ANFR and CSA. UK and France are key players in developing the European regulation and in its implementation. UK and France operate mainly through Europe for RF Allocation. Like other CEPT countries, they contribute to the European Common Proposals forwarded to ITU. The individualised UK and the US merged the regulation of broadcasting (transport and content) and telecommunications (wire and wireless); this is not the case in collectivised France and Ecuador; French CSA and Ecuadorian CONARTEL regulate broadcasting (content and transport). CONATEL

and Regulations'.

[29] The resemblance of countries with similar latitude is remarkable: in fruits and vegetables, agriculture; local markets and local tribes, trade; traditions, behaviour; economic polarity and poverty.

converges fixed telephony and wireless.

UK, France and the US are developed countries, regulating their RF spectrum in a rational way: promoting the interests of citizens, consumers and business, promoting competition and cautious of uncertain risks. The three countries separate the regulation of civil and military RF by different agencies; in Ecuador CONATEL is responsible for the civil and military RF spectrum. The French Ministry of Defence and the NTIA seem relatively more influential than the UK Spectrum Strategy Committee in protecting the military RF spectrum[30] and present military allocations. This is another example of the wireless 'risk-seeking' policy of the UK. The defence needs of US, France and UK impact the global RF allocation. In the historical context, it is important to note that even before the Berlin Radio Conference of 1906, the RF public correspondence stations were immediately blocked, because the 188-500 KHz band had been effectively occupied by the military and maritime radio services, especially those of France, Germany and UK (Codding 1959:80).

The US telecommunications did not require privatisation, as they were never operated by the state. The regulatory framework in Europe inherited the original hierarchy of the large administrations, historically operating the fixed telephony and telegraphy as a state monopoly. The European collectivism (mainly in France and Germany) is still significant in contrast to the individualist US; however, the UK is different. The way in which the UK, France and the US control and measure the RF spectrum highlights the French collectivised rationality versus the UK and US' individualised approaches: the US and UK monitor RF sporadically; France has a systematic centralised control, monitoring the spectrum on a regular basis and maintaining a central database of all RF transmitting stations. The industry is more dominant in the USA's regulation process than in UK and France. Europe holds diverging views on state intervention; in addition UK, France and the US have different opinions on how telecommunications and RF regulation serve the public; they balance differently the needs of government, industry and the public.

UK and the US are mostly geographically isolated from their neighbours, whereas France borders six countries (and Ecuador two). The French and Ecuadorean centralised view, legal origin and interpretation of the citizen-consumer and industry’s welfare are different to those of the UK and the US. For France and Ecuador the state may exist per-se; the regulators may change the 'society view'; in the US and UK the regulator has less choice, it serves the individual. The RF spectrum is owned by France and Ecuador, so secondary RF trading exists in the US and the UK, but not in France and Ecuador.

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[30] See the restrictions of France on SRD in 2.4 GHz, the ANFR tests on co-sharing in 5250-5350 MHz RLANs and Radars, and the US activities in ITU to protect their Radars.

The regulatory framework of UK and France is more vibrant than that of the US, due to intensive meetings taking place among administrators in diverse European frameworks (EC, CEPT, ECC, ETSI, ERG, RSPG, IRG…; the precedent chapter specifies the abbreviations). Moreover, due to attempts to follow the EC regulatory framework and European integration, there is no constancy in the UK and French e-Communications regulatory framework; in the last years, administrative changes have been very frequent, in contrast to the US. Ofcom is the most dynamic in RF initiatives, almost 'hyper innovation'[31]. It will be difficult for the US to continue leading the telecommunications RF regulation, due to the determined European regulatory and standardisation efforts, and the spread of European rules and standards (such as GSM/UMTS and DVB-T) outside of Europe.

There is tension among the Member States in Europe due to different sets of attitudes, assumptions, management doctrines and worldviews (Hall, Scott and Hood 2000:34). In the US, the different worldviews lie between the two leading parties. Despite their differences in styles, the similarity of developed countries such as France, UK and US can be explained as culturally-derived: due to adoption of the same paradigms. The dominance of the US superpower and its strong industry (wireless suppliers and service providers) influenced European telecommunications and regulatory frameworks after World War II, toward deregulation and liberalisation; WTO and OECD are following the same path. Ideas from USA are more easily accepted in UK than in France. The similarity of UK and USA styles, relative to France and Ecuador, can also be explained by culture: the use of the English language increases trust between the countries[32], history (allied countries in WWI and WWII), *common law* (versus *civil law*), Protestantism (versus Catholicism) and individualism (versus collectivism).

The cross-Atlantic diversity (UK/ France versus USA/Ecuador) in standardisation is apparent: there are variations in - electricity current (110/220, 50/60 Hertz), broadcasting (sound and video) RF bands and channel separations, and TV standards; see *Table 5-1*. The EU and the US try to promote their regulatory approaches; they are determined to fit the international regulation and standards to their own. The hegemony of the three developed countries is strong in their respective colonies, ex-colonies and spheres of geopolitical influence. UK, France and the US propagated their wireless standards during the 20th century (e.g. UK PAL, French SECAM and the US NTSC). In the 21st century, there have been no specific UK or French standards developed (or significant standardisation institutes), as they follow the EU/CEPT allocation and ETSI standardisation. At present, countries apply the

[31] Burgess 2006:333 citing Moran 2004 *The British Regulatory State: High Modernism and Hyper Innovation*.

ETSI (such as UMTS cellular and DVB-T Digital TV) or FCC wireless standards (CDMA2000 cellular and ATSC digital TV).

Regulatory Frameworks of *Case Studies* - Conclusion

Understanding the regulation of CEPT, EU, *CAN* , UK, France, USA and Ecuador provides a thorough knowledge of the telecommunications and RF regulation in all EU countries (including a key player like Germany), all Europe (including Russia), and practically all the Western world (such as Australia, Canada, Israel and New Zealand). However, the analysis does not clarify the regulatory framework in the Far East (for example, Japan, South Korea and China). The comparison of the regulatory frameworks of the countries studied provides an enlightening perspective on wireless regulation. The developed countries UK, France and US set the world's RF regulatory framework. The communications regulatory frameworks in UK, France and USA serve as models to national regulation. Developing countries have no advanced wireless industry, and they cannot manage an independent RF regulation and standardisation policy. However, most of the countries in the world are at the developing stage. Ecuador's *case study* is instructive for other developing countries, on how to develop its regulatory framework or adopt that of others. There are many similarities between the collectivised France/Ecuador versus the individualised UK/USA; France and Ecuador are central-planning, Catholic, apply the *civil law*, converge broadcasting (infrastructure and matter) in a separate authority and emphasise engineering (less economic influence). The wireless rules of the *case studies* indicate how a society functions and its decision-making rationalities. The choices in regulation of the countries studied may be bound by culture. There are differences in the regulatory frameworks that can be explained by different cultures (religion and legal origin) and rationalities. The resemblance between Ecuador and France is notable as the similar traits cross the Atlantic, the Latitudes (Paris 49^0, Quito 0^0) and the development status. The collective Catholicism, the French worldview inspiration, post-revolution legislation and Napoleonic *civil law* may provide the explanation for this similarity. The Latitude has an additional impact on wireless rules and standards as it is correlated to the language, religion and legal origin: the ex-colonies of Protestant *common law* UK are more distanced from the Equator, than the Catholic *civil law* ex-colonies of France, Spain and Portugal (see the *Indicators* chapter subsection 2.1.1 and Appendix B *master-data*).

Table 5-1 compares and contrasts the regulatory frameworks of UK, France, USA and Ecuador.

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[32] Licht, Goldschmidt and Schwartz (2004:32) relate English-speaking countries to 'good governance'.

Table 5-1 Regulatory Framework, overall comparison

	France	UK	US	Ecuador
Joined ITU	1865	1871	1908	1912
First telecom law	1852-1870	1904	1912	1972
First type of regulatory body	Directorate-General 1941	Postmaster-General (minister) 1904	Secretary of State for Commerce; 1926	*Ministerio de Obras Publicas y Comunicaciones*
Regulatory body	ARCEP, ANFR and CSA	Ofcom	NTIA and FCC	CONATEL and CONARTEL
Policy maker	Ministry of Economy and Industry	BERR	NTIA	SENATEL and SUPTEL
Actual Planning	Central-planning and market-based; collectivised	Market-based, Light-touch; individualised '*laissez-faire*'		Complex central-planning ; 'command and control'
Assignment and allocation of civilian and military RF spectrum	ARCEP (telecom) and CSA (broadcasting) assigns the civil RF. ANFR manages the overall spectrum. Ministry of Defence assigns military RF.	Ofcom manages non-military RF. The Spectrum Strategy Committee allocates Military use	FCC regulates civil RF; NTIA regulates the military RF	CONATEL manages civil and military RF spectrum. CONARTEL regulates broadcasting: TV and Radio
Convergence: wired versus wireless, content versus transport	Only broadcasting is converged: CSA regulates content and transport; ARCEP licences wired and wireless. Telecom and Broadcasting remain separated	Ofcom regulates wire and radio, broadcasting and telecoms	Since 1934: FCC regulates wire and radio, broadcasting and telecommunications. NTIA regulates governmental RF	Fixed and wireless telecoms are converged; broadcasting and telecoms are separated
Introduction of privatisation	1988- creation of France Telecom	1981- British Telecommunications Act	1934- Communications Act	1992 (only liberalisation)
Weighting factor	Technical/ Engineering	Economic	Legal	Technical/ Engineering
Licence Exempt	1990		'Part 15 Devices' since1938	1992
Type Approval (TA)	R&TTE Directive: simple and effective		Verification, declaration of conformity, certification	As in US; but, the TA is specific to the importer
Original dominance on broadcasting	RFT (*Radioffusion Télévision Française*) is founded in 1945 as a broadcasting monopoly; 1982 private broadcasters are licensed	A state enterprise BBC, 1922; the broadcast's transport privatised in 1985	Private Broadcasters	Missionary HF broadcasting 1931 by HCJB
Colour TV begins	1967		23 January 1954	20 July 1969

	France	UK	US	Ecuador
Ending analog TV	End November 2011	2012	18 February 2009	A committee will propose
RF control and monitor	Systematic and centralised; 57 fixed monitoring stations; full database of RF stations	Sporadically;1monito-ring station in Baldock and up to 70 vehicles	80 VHF/UHF monitoring vehicles	4 fixed and 4 mobile VHF/UHF monitoring stations
Size (Km^2)	545,630	224,820	9,158,960	276,840
Population[33] (m)	62.8	60.5	297.0	13,8 (July 07 est.)
GDP per capita (£)	19,242	21,322	24,017	2,446
Language	French	English		Spanish
Religion	Catholic	Protestant		Catholic
Legal framework	*Civil Law*	*Common Law*		*Civil Law*
Main wireless geopolitical Influence	Francophone countries, formerly colonies and colonies (eg *Françafrique*) USSR; *civil law* countries	British Commonwealth and old colonies	**North** and Latin America, Asia, Australasia and Africa	Influenced by the US and EU
Cellulars/100 inhabitants 2006 (2003)	85.1(69.6)	116.4 (91.4)	77.4 (54.6)	63.2 (18.3)
CPP	Calling Party Pay; the phone caller pays		Cellular pays for the call: RPP	CPP
Broadcasting channel separations	Radio AM 9 KHz		Radio AM 10 KHz	
	Radio FM 100 KHz		Radio FM 200 KHz	
	TV: 7 MHZ in the VHF, 8 MHz in the UHF		TV: 6 MHZ in the VHF and the UHF	
Radio FM RF bands	87.5-108 MHz		76 -108 MHz	
TV standards	Analogue: SECAM	Analogue: PAL	Analogue: NTSC	
	Digital standard : DVB-T		Digital standard: ATSC	Not Decided yet
TV terrestrial RF bands	VHF: 47-68 MHz, 174-230 MHZ _ in Europe, except UK; UHF: 470-862 MHz		VHF: 54 -72 MHz, 174-216 MHz ; UHF: 470-608 and 614-806/890	
Mains electricity	220 Volts; 50 Hertz		110 Volts; 60 Hertz	

33 The following sources were used: population- US Census Bureau (mid 2006 figures), GDP - World Bank (2006), exchange rates - IMF (average during 2006)

6 Societal and Risk Concerns: Comparing UK, France, USA and Ecuador

There are many issues in national RF regulation, where regulatory decisions are made or could be made that are not necessarily the single most technically efficient and rational answer; there are others that people in different cultures and geographies may judge differently. This section explores the subjects that reflect policies and rationalities. This section contributes to the debate about the relative tendency to precaution of the US versus Europe. After the comparison of the regulatory frameworks in the last sections, the licensing regimes are now compared through the societal and risk concerns prism. The licensing is performed at a national level; regulatory objects with different solutions in UK, France, the US and Ecuador are highlighted. These particular regulated (or non-regulated) RF items were chosen as their licensing reflects the national societal and risk concerns. The objects of study, all associated with RF, identify their cultural roots and pinpoint different styles of decision-making and regulating uncertain risks. As the UK and France are following EU directives, the comparison is mainly of Europe, the US and Ecuador. The wireless rules and standards of the EU (European Union) and US are the most influential around the world; the main contrast is between these two hemispheres. In this way, a careful analysis of typical issues that concern EU and US reveals their regulatory framework, and the situation in other countries that choose to follow their regulation. Supporting data for the values and tables is detailed in the RF introductory section.

The typical RF regulatory issues examined are the maximum permitted *spurious emissions* and *human hazards* levels, licensing exemption (short range devices on an unlicensed unprotected basis) and top-down mandated technology versus market-based solutions. The objects enable cultural assessment according to societal and risk concerns; all are related to risk and uncertainty. It is interesting to note that after the terror attacks of September 11th 2001 and London 7 July 2005, countries are less tolerant of taking risks with their emergency RF services: Ambulance Service, Fire Brigade,'911' in the US and '112' in Europe.

Spurious Emissions and Power Limits

RF interference is the risk that regulators must manage. The different permitted *spurious emissions* levels in Europe and the US are extremely significant; see the comparison tables 6-10 and 6-11 in the RF introductory section: in the US the allowed spurious levels are up to 5,000 times (!) higher in power than in Europe. The restrictive *spurious emissions* levels in Europe are typical of risk-averse regulators. Another example is the significant difference in emissions masks allowed for the Ultra Wideband (UWB); the differences in the US and Europe are up to 30 dB (1,000) in UWB power masks; see Figure 6-1; the Japanese mask is between those of ETSI and FCC.

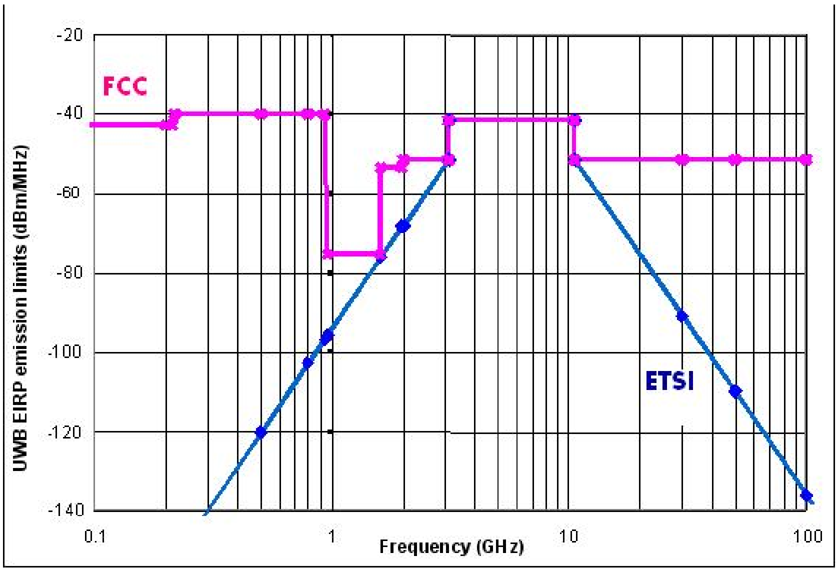

Figure 6-1 UWB emissions masks Europe (ETSI) versus the US (FCC)[34]

The US allocates RF spectrum to UWB, whereas Europe does not yet do so. We encounter again, the contrast between the American policy of innovation and the European fear of harmful interference to primary services; the US represents the entrepreneur (as with *spurious emissions* and *human hazards* levels) and Europe the 'command-control' approach. In Europe and the US the limits are conceived after discussions with manufacturers. However, the CEPT approach is to conserve the spectrum resources; Europe is more sensitive to ecological issues (such as *spurious emissions*) than the US. In addition, Europe is more densely populated than the US and the probability of interference is therefore higher. Europe prefers 'harmony'; 'harmony refers to an emphasis on accepting the social and physical world as it is, trying to comprehend and fit in rather than to change or exploit it' (Licht *et al.* 2004:6).

The goal in Europe and the US is the same: the benefit of the consumer. The difference between them is the higher tolerability to risk (RF interference in this case) of the American approach. The US relies more on technology developments overcoming possible problems.

Human Hazards

At an RF of 1 GHz (typical to cellular GSM900 radiation), the power density level of ICNIRP (International Commission on Non-Ionizing Radiation Protection) and Europe is *f*/200. The US ANSI level is *f*/150; it is slightly higher, by 4/3 (200/150), compared to the ICNIRP threshold. UK, France and Ecuador follow the ICNIRP levels. The supporting tables appear in the RF introductory section. These findings are comparable to the distinct Europe / US policies on plasticizers in children's toys and Genetically Modified Organisms; see Lofstedt and Vogel (2001:404). It is important to observe that the US is more risk averse than Europe, as regards the permitted SAR (Specific Absorption Rate) from the cellular terminal. The

34 'Update of Worldwide UWB Regulation Status' Infocomm Development Authority Singapore; March 05.

ICNIRP threshold (adopted by EC) is 2.0 W/kg, while the US limit is 1.6 W/kg. The US perception is more rational (at least compared to Switzerland and Italy, dividing ICNIRP power levels by 100), as the RF radiation power from the cellular handsets is much stronger than the signal from the base stations: mobile phones are much closer to our head; see surprising results, Sadetzki *et al.* 2008.

License Exempt Devices; Short Range Devices (SRD)

The Licence Exempt is a successful example of an unregulated field; the *individual* (end user or innovator) operating unlicensed devices, versus the licensed *collective* operator. In the US most RF spectrum is available to the License Exempt devices; Europe has opened less RF bands, with more restrictive limits. The US permits higher levels of emission and less regulation (Paik *et al*. 2002: table 6, p.11). It allows toy microphones to operate in the sound broadcasting FM bands (76-108 MHz), and unlicensed electronic devices in the TV bands[35]. US, Canada and Japan allocate more RF bands (for example, 902-928 MHz in US/ Canada and the additional 2483.5-2500 MHz in Japan) and more power than Europe[36]. Similar results appear when comparing the allowed powers and bandwidths for Wi-Fi, Bluetooth and RFID. Moreover, in the US service providers may operate public services in SRD bands[37].

It is important to note that the R&TTE Directive goes much further in its liberalist approach than the FCC, where type approvals are concerned. FCC requires fewer tests (no need to conform with the EMC Directive); however, the US is more stringent in its type approval process. Instead of the European self-conformity and the UK specifying that Short Range Devices require less intervention from the state, the FCC asks for certification for these low power transmitters (the required filing process takes 6-8 weeks) and screens out interfering devices. The European self-conformity concept of '*laissez passer*' for equipment in harmonised RF bands means that the R&TTE norm allows the introduction of equipment into the market (undergoing tests only later *ex-post,* if and when there are complaints), and imposes the responsibility into the hands of manufacturers. The FCC still has a prior *ex-ante* certification regime (noting FCC number on the equipment), which does not exist anymore in the EU (in the case of SRD and GSM equipment, for instance).

The FCC '47CFR Part 15', introduced 60 years ago, influenced the rationale of the European SRD concept (1990) and the ERC/REC 70-03 2008 ‘Relating to the Use of Short Range Devices (SRD)’. The Europe/ US difference might be rooted in diverse cultural attitudes, and collectivised central-planning versus individualised market-based approaches. The European

[35] Press Release ‘FCC proposes using TV band for unlicensed operations’ 14 May 05.

[36] See 47C.F.R.§15.247 in the 2.4 and 5.8 GHz bands **4 W**; relative to **100 mW** European ERC REC 70-03.

[37] The current constraint on the use of licence-exempt bands for the provision of public access services will be

civil law proposes that you act within the **text** of the law; 'decisions give predominance to written submissions' (Djankov *et al.* 2003:4); therefore, the RF bands for the European SRD are detailed. In the US, constitutional and *common law* predominates, where a person may do whatever he/she chooses, unless the law prohibits it; referred to by the Enlightenment thinkers as Liberty. Therefore, CFR47 Part 15 delineates only the RF bounds that are not to be used.

Imposed Technologies in Wireless Licenses

This section explores the centralised European approach of imposing technologies (at least in the 20th century), while the US implements a 'technology-free' regime of regulation. Dictated technology and harmonisation force the creation of a single market, even where one market did not exist. The vast majority of the RF spectrum of interest for commercial services is licensed; the licence defines if the RF operators can either deploy any standard they wish, or are restricted to a specific technology. The license of the GSM operators in Europe tied the frequencies 890-915MHz and 935-960 MHz to technology. Neutrality in this area facilitates technological competition, research and innovation, and allows operators to implement advanced services without going to new RF bands (e.g. Americans operating AMPS, TDMA, GSM, and CDMA cellular standards in the band 824-849 MHz and 849-894 MHz); whereas the advantages of a top-down approach are interoperability, roaming, seamless services and less RF sharing issues. Interoperability (for example, of digital interactive television services) is encouraged in order to ensure the free flow of information, media pluralism and cultural diversity (Cave Report 2002:218).

Despite the Framework Directive 2002/21/EC (articles, 17, 18, 30 and 31), the European regulation is still not completely technology-neutral in 3G cellular licences; the "authorisation" Directive 20/2002/EC allows it[38]. The Cave 2002 report proposes to limit European top-down technology, in order to allow 'technology competition and innovation' (Recommendation 4.3, p.35). In France, the cellular licenses proposed on 19th March 2004 and later *(Décision n° 06-0140 Décision n° 06-0239)* to *Orange France* and *Cégétel* do not dictate the specific technology to be employed, but oblige the ITU IMT-2000 technology. Similarly to the UK, France understands the advantages of harmonised European technology, continues to move slowly toward the freedom of technology, but it still obligates the third generation standard IMT-2000.

The US spirit of entrepreneurial innovation does not allow the FCC to impose any technology; nothing ties the spectrum to technology. This minimum-involvement of the

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removed in UK (Recommendation 8.2 of 'Cave Report' 2002; the recommendations are implemented).

[38] Directive's Appendix: where 'frequency (and numbering) resources may be allocated using an individual authorisation'; thus, the obligations enable the regulator to enforce technology (and standards).

regulator illustrates how the US administration delegates power to industry and service providers. This bottom-up policy is derived from the individualised worldview, a ‘bazaar’ of technologies, as opposed to the European centralised rationality, a ‘cathedral’-like top-down design. It is interesting that the technology-neutral approach taken by the US slowed down the development of the mobile market in the US and overseas. As there is no one imposed wireless standard, Americans are unable to roam simply (as the Europeans) outside the US, with the same terminal that they use at home; there is no interoperability and no economies of scale for vendors and operators. This is in complete contrast to the national and worldwide interoperability of the European top-down mandated GSM technology. It is surprising that the GSM-dictated technology happens to engender better competition[39] relative to market-based 'bazaar' of technologies. The success of the European GSM is the epitome of how efficient the cooperation and harmonisation can be; GSM is the example why technologically neutral may not always be the best approach.

Societies, whose cultures view the individual as an embedded part of hierarchically organised groups, are more likely to accommodate exercising power from above (Licht *et al.* 2004:8). The US neutral technology follows the ‘atomised’ approach to organisation (Seedhouse 2002:62-3), putting individual before collective benefit: a lonely figure battling collective pressures; this is the classical ‘cowboy from the far-west’. This is in contrast to the top-down harmonised technology in Europe, which is the symbol of the collectivised egalitarian way: family, solidarity, with non-competitive group support and top-down leadership. There is an apparent difference within Europe between UK and France; in CEPT there is a compromise between France which slows technology neutrality, and UK which promotes it. Cave Report's liberal proposals bring UK closer to the US.

6.1 Inter-relations UK, France and the US

Wealthy countries are similar[40]: their wireless regulation is objective, transparent, non-discriminatory, flexible, dynamic, fair, proportionate, promotes competition and secures an optimal use of RF. Three different developed countries (UK, France and the US) have implemented such a similar RF regulation. The national laws, regulation and standards become very similar, to maintain competition and ease free circulation. However, countries still maintain formal institutional arrangements, and follow a unique path of development.

[39] For the same GSM standard, the competition focuses to improve the universal equipment and the service.

[40] So begins Leo Tolstoy's *Anna Karenina:* All happy families are alike.

UK and the US

The current presumption that Ofcom should exempt from licensing any equipment that does not cause harmful interference is the exact view held by the FCC on unlicensed electronic devices since 1938. The UK and US conduct similar regulatory styles. Cost is also a societal concern; the decoupling of issues, invoking societal concerns from considerations of cost and practicality should be avoided (Ball, Boehmer-Christiansen 2002:35-7). It seems that the UK and US are more concerned about cost than France: the RF trading is promoted by UK and the US. The UK and US coordinate for ITU Radio Conferences; they share common roots, language, legal origin (*common law*), the Allied Countries history, a protestant worldview, and sense of belonging. This is all reflected in similar RF regulation; the FCC's regulatory framework also inspired the Ofcom's structure. The UK and US realise a schematic liberal interpretation: "if it is not written, it is legal" [41], as opposed to the European view "if it is not written it is illegal". The UK and US share similar styles in regulating the e-Communications network and service. UK belongs to ITU-R Region 1 RF allocations and US to Region 2; the UK is much closer to France than to the US in RF allocations.

UK Stands between Europe and the US

The UK and the US are market-based societies. As regards wireless regulation, societal concerns and risk, the UK stands between Europe and US: geographically in Europe, but an island isolated from the continent of Europe; part of the old world but at the same time, the UK embodies the spirit of the new world. The UK refuses to recognise the EU authority above the Queen; the UK joined the EU in 1973 (France in 1957). As part of the EU, the UK is bound and guided by the European market (without adopting the "Euro"). The UK and US 'light touch' approach opposed to the European heaviness of regulation, interventionism and bureaucratic inefficiency could be derived from the legal origin conflict of *common law* versus *civil law*; see Djankov *et al.* (2003:35). 'Ofcom' is the source of new innovative rules, but is at the same time bounded by European harmonisation. The UK is part of the EU when it comes to levels of *human hazards*, *spurious emissions* and wireless standards; however, the UK leads the way in secondary RF trading.

Europe and the US

The fact that community law takes precedence over national law provides a strong unitary framework for the EU (the commentary of Slater in Lofstedt and Vogel 2001:414). However, unlike the US, where a nationwide harmonized approach is ensured, the European regulatory bodies are in a much more difficult position since they have to coordinate and synchronise

[41] Quoted by an official in Ofcom; it can be related to 'innocent unless proven guilty'.

with many national regulatory bodies. In addition, the differences between the individual states that make up the US are certainly smaller than the differences between Member States of the EU; nevertheless, comparisons between the regulatory systems of the two should take into account this underlying complexity.

The main differences in the regulatory trends may be attributed in part to differences in the political structures on both sides of the Atlantic. The RF standardisation in Europe can be compared (again) to the carefully crafted 'cathedral', and the US to the great babbling 'bazaar'. There is a contrast between the regulatory styles in Europe and US - the hierarchical versus the market model: the Southern European Napoleonic code of top-down decisions in the name of equality, versus the Anglo-Saxon culture of market and freedom to compete. The US federal government is much more dominant than the EC (European Community) integrating force, at least legally. Competition and market forces have always been strong factors in the US economy, whereas Europe held on to the idea of regulation by central government. This could have been the result of the birth of the US, as a rebellious statement against the old world. The US regulatory framework promotes minimal intervention. Recently, Europe became convinced that the liberal 'light-touch' US approach is advantageous and is moving in this direction, guided by EC. The differences between collectivised/individualism (in *spurious emissions, human hazards*, licence-exempt RF power and bands, free-technology) may be explained by the American deep devotion to innovation: looking at the individual as the source of all power. Moreover, because the US has traditionally suffered from a lack of RF planning (relative to Europe), paradoxically that has driven the development of advanced wireless products that simplify wireless solutions.

Societal and cultural factors shape the risk assessment for each continent. Trends in consumer and environmental regulation have resulted in stricter European regulations and less of a tendency to risk seeking. In the US, there is more trust placed in the FCC and science than in Europe toward their counterpart EU institutions and decisions. Globalisation blurs the national characteristic of the equipment, standards and regulation. Today it is impossible to identify a French or British wireless standard: their wide-ranging contributions are incorporated into ETSI standards. Although the UK and French wireless regulations may be different, the UK and France export the same European standards to their geopolitical associates. In the 20th century, in the leading cellular industry, there was a clear advantage to the European collective central-planning, long-range view, and top-down technology led by France and Germany. The centralised top-down 'command and control' explains the success of harmonised GSM versus the US bottom-up cellular standards. The achievements of GSM have been repeated with other European RF technologies spreading outside Europe and Africa such as DECT, UMTS and DVB-T. The European unification and wireless harmonisation are unique. The advantages of one European wireless market are clear for economies of scale; however the super-state approach might control, mastermind and annul any 'nationality split'; the Europeanisation also includes renunciation of sovereignty in national wireless regulation and standards.

The EU and US Hemispheres- Summary

The geography of the country identifies its Latitude, which is highly correlated to income and the penetration of new wireless technologies. Longitude is the main separator between the hemispheres. The EU and US zones of influence divide the world. The European sphere can be identified by these characteristics: CEPT RF Allocations (ERC Report 25), CEPT ERC/ECC Decisions and ETSI standards (such as UMTS and DVB-T). Europe is more sensitive to ecological issues; *human hazards* and *spurious emissions* are a part of ecological pollution. The US hemisphere can be recognised by the CFR47 RF allocations and rules (including the liberal Part 15), more tolerability to risks (*spurious emissions*, *human hazards*, power levels and bands of SRD), American standards (such as CDMA2000 and ATSC) and the new RF innovations (like SDR and UWB). UK implements European standards, but shares the 'North- American' liberal/individual view with its ex-colonies, the other Allied Countries (Australia, Canada, New Zealand, USA), in contrast to the state (community) worldview. The contrast of collectivised Europe and the market-based US reflects the debate between the continental Social model and the 'Anglo-Saxon liberalism'.

These two worldviews lead to different regulation: the European view seeks benefit for the greatest numbers; it may prefer the 'collectivised' rationality and the belief that the 'needs of the many may outweigh the needs of the one'. The American view offers sovereignty to people; it may prefer the 'individualised' rationality. Different approaches guide to alternate priorities of serving the citizen, scarce resource utilisation, societal and risk concerns, interpretation of the public interest, protection of citizen rights and property and interpreting the role of the administration. Far Eastern countries (such as China, Japan, Taiwan and Singapore) and the Arab countries may follow different priorities, ideologies and rationalities to the four Christian cases (UK, France, USA and Ecuador), as they apply a different importance to the supremacy of the individual.

6.2 Societal and Risk Concerns: Europe, USA and Ecuador

Table 6-1 compares the societal concerns and risk objects to provide a framework to contrast EU and US wireless regulatory rationalities. Table 6-2 and Table 6-3 contrast the European (and Ecuador) central-planning and the US market-based rationalities.

Table 6-1 Societal and Risk Concerns: Main differences between Europe (France and UK) and USA

<table>
<tr><th rowspan="2">Regulation Object</th><th colspan="2">Europe</th><th rowspan="2"><u>USA</u></th></tr>
<tr><th>France</th><th>UK</th></tr>
<tr><td>Spurious Emissions</td><td colspan="2">Stringent</td><td>Variable</td></tr>
<tr><td>Precautionary Principle</td><td colspan="2">Dominant</td><td>Not Implemented</td></tr>
<tr><td>Power Density (W/m²)[42]</td><td>4.5 (international level)</td><td>33 (very flexible; see case study)</td><td>6 (flexible)</td></tr>
<tr><td>Specific Absorption Rate (W/kg)</td><td colspan="2">2.0 (international level)</td><td>1.6 (conservative)</td></tr>
<tr><td rowspan="2">License Exemption (LE) SRD in Europe and Electronic Devices in USA</td><td colspan="2">Specific RF bands and limited power for SRD in ERC/REC 70-03. Licence needed for commercial use; limits to connect to the public telephone network.</td><td rowspan="2">No License for commercial use; LE emissions in all RF spectrum, more power</td></tr>
<tr><td>Additional limits to ERC REC 70-03</td><td>Implements REC 70-03 more liberally</td></tr>
<tr><td rowspan="2">RLANs in 2.4 and 5 GHz,
a specific case of Licence Exempt</td><td colspan="2">RLAN access to public electronic communications networks. No need for licence</td><td rowspan="2">Bottom-up; market-based solutions. More power, more bandwidth</td></tr>
<tr><td>Only Private use does not require any licence.</td><td>No Licence for commercial use; no limits on connecting to public network</td></tr>
<tr><td>Type Approval and free circulation of equipment</td><td colspan="2">R&TTE (and Self Conformity by manufacturers) is much more flexible than the US</td><td>Certification also for low power transmitters</td></tr>
<tr><td rowspan="2">Technology Neutrality</td><td colspan="2">Some top-down mandated regulation</td><td rowspan="2">Market-based solutions; technology-free</td></tr>
<tr><td>Some top-down mandated regulation</td><td>Limits the EU top-down technology</td></tr>
<tr><td>Radio broadcasting (since 1920)</td><td colspan="2">Organised as national services by an administrative organ of the government</td><td>Carried out exclusively by private operating companies</td></tr>
</table>

[42] General public, 900 MHz (GSM frequencies), based on ITU-R 2005 Recommendation BS.1698.

Table 6-2 The European central-planning versus the US market-based**: European** and **Ecuadorian** Rationalities

Ideology, Policy, Rationality	Regulation and Standardisation	Worldviews, Values, Goals	Regulating Uncertain Risks	Network Services and Public Assets	Illustration
Collectivism; ‘power in the hands not of a minority but of the greatest number’; public interest; group welfare; harmonisation; tradition; *Civil law*: equity, environmentalism; sense of community.	Hierarchy; Command and Control; centralised; Bureaucracy, top-down governance and standardisation; detailed standards; formalism; interoperability and roaming; static allocation; scarcity; Coordinated Market Economies; power to the state, national control; consensus; rules of instruction; some delay.	Equality/ Fraternity/ Liberty; social justice and values; order, authority; loyalty; solidarity; research and development; long-term national goals; *collective constructs* and action; the regulator is the public master and patron; Catholicism: universalism, divine providence, brotherly love; 'national' press and media.	Risk averse; worst-case assumptions; permit low RF *spurious emissions* and *human hazards*; Precautionary Principle (ALARP in UK); conservatism; rights and licences; suspicion; sustainability, stability; social past and social future are balanced.	Control prices and services; non proprietary and non patent rights, still some top-down technology; group-oriented; preserves and holds scarce resources; administrative assignments; better sharing; Quality of Service; collective utilitarianism; the view of the strong players.	Cathedral planning, paternalism, deliberately designed; GSM, Leviathan; philosopher- king; *collective unconscious*; licence, intervention; *Homo Hierarchicus*[43]*;* Engineer; Harmony; protective father; the needs of the many outweighs the needs of the individual; France and Ecuador (not UK), common future; Socialism.

[43] Dumont L. 1966 *Homo Hierarchicus*, London: Weidenfeld and Nicolson.

Table 6-3 The European central-planning versus the US market-based**:** the **US** Rationalities

Ideology, Policy	Regulation and Standardisation	Worldviews, Values, Goals	Regulating Uncertain Risks	Network Services and Public Assets	Illustration
Individualism, Freedom; Government of the people, by the people, for the people; pluralism; the licensees should be trusted; public consultation; feedback loops; look forward; *common law*: individual property rights; industry.	Market, 'light touch'; deregulation, self regulation and self management; full liberalisation, bottom-up governance and standardisation, technical neutrality; informality; flexibility, choice and diversity; favours also small businesses; technologies to end RF scarcity; Liberal Market Economies; favour the citizen; fair-play; hurry.	Competition and efficiency; liberty; 'inequity is normal, healthy and moral'[44]; individual innovation, ownership; spontaneous; survival of the fittest; the regulator is the public servant; Protestant: Reformation, predestination, own responsibility; an absence of a widely read national press.	Risk prone; spread risks; specific evidence, prudent-avoidance and science-based risk assessment; permit high *spurious emissions* and high *human hazards* levels; adaptation; more licence-exempt; trust the regulator; growth, progress, economically viable solutions; short-term, present; technology- society.	Private-sector controlled; free market; bottom-up technology; RF Allocation to the most economic; minimum price to the end-user; RF resource is a property; secondary market trading, low access barriers to scarce resources; consumer sovereignty; the view of the individual entrepreneurs; innovative wireless regulation (SDR, UWB).	Bazaar; medieval cities; invisible hand; *laissez faire, laissez passer*; free rider cowboy from the wild - west; Internet, Wi-Fi; *Homo Œconomicus*; bottom line; *carpe diem* (seize the day), *que sera sera* (what will be will be); Capitalism.

44 Benjamin *et al*. in Kasperson J.X. and Kasperson R.E. (eds) 2001:483; quoting Kahn, Brown and Martel 1976.

6.3 *Societal* and *Risks* Concerns of *Case Studies*- Conclusion

This chapter compares how the UK, France and the US have tackled certain objects of regulation. Each approach to regulation is compared, and the question of whether and how to regulate is discussed. The different regulatory styles are contrasted: UK is an Anglo-Saxon country where the market model governs; at the same time, it follows European Regulation, where the hierarchy and top-down decision-making (in the name of equality) are paramount. France is historically centralised and (together with Germany) is the core of the unified EU, a single harmonised wireless market. Due to EU telecommunications directives, UK is closer to France (and the rest of Europe) than to the US; however it is closer to the US in regulatory style. The US and UK lead wireless innovation and liberalisation. A large country with a lower density of population, the US can tackle more RF interference as the relative distances between emitters are longer.

There are varying regulatory methods in Europe and the US; different approaches to emerging issues such as environment, health, regulating uncertain risks and other societal concerns; and conflicting attitudes to the role of the state versus the individual. For a long time the US vision has been focused on the consumer's viewpoint, promoting small business and entrepreneurs. This policy is reflected in RF deregulation, liberalisation, freedom of choice in technologies and more RF spectrum given to License Exempt devices. The spirit of the US is that RF spectrum belongs to the public; market tests are the most efficient methods of determining wireless telecommunications development. The federalisation of RF in USA is obvious; however, the interoperability of cellulars among states is not as developed as in Europe with its GSM technology, due to the US view of innovation believing that technology should not be imposed. The US worldview affects RF regulation; the Calvinistic idea (being rich is blessed by God) and the Constitution, which protects business, have an influence on the US RF regulation. The attitude that federal government should not intervene extensively in business still exists. The US has a clear policy of allocating high amounts of the License Exempt RF spectrum and less limits on their RF power, bandwidth and *spurious emissions*, to facilitate the radio industry and the entry of small operators; the US puts the individual in the centre, compared to the big service providers in Europe.

France, UK and the US do regulate their RF 'rationally'. France and Ecuador regulate RF in an egalitarian (ephemeral) style; the UK and the US in an individualistic (benign) way. These rationalities are derived from their different worldviews. The US regulation regime rates *spurious emissions* as lower risk, relative to Europe. The *case studies* illuminate the different societal and risk concerns across the Atlantic related to the RF spectrum.

6.4 Summary of RF Regulatory Objects in Europe (UK, France) and the US

Europe and the US are the dominant superpowers in e-Communications. The UK culture is more like that of the US[45]. It would be culturally more satisfactory for the UK to join with the US on RF; but geography and practice link UK closely to Europe. After careful evaluation, including consultation with many international experts as external observers[46], the conclusion is that the regulations in Europe and the USA have many similarities, as concerns most RF objects of regulation. Globalisation, ITU regulation, American influence and the pervasive western culture are the main reasons for the resemblance. The main differences in regulation between Europe and the US are:

1) The US is much more lenient in allowing *spurious emissions* to the RF transmitter and interference to the receiver;

2) The US allocates more RF spectrum with less regulatory and technical limits to Licence Exempt devices. The US is more active in promoting new technologies than Europe;

3) Europe has a greater acceptance of top-down, mandated regulatory standards compared to the US, which prefers market-based solutions;

4) The permitted *human hazards* from broadcasting and cellular base stations are less restrictive in the US, compared to Europe, which adopts the international (ICNIRP) levels;

5) Surprisingly, contrary to other regulation objects, Europe is more liberal in the equipment type approval and free circulation policy, and in the allowed emitted power SAR from a cellular handset.

The more restrictive SAR threshold may reveal again the different societal concerns in the individualised US: a low SAR level from one's personal phone. This is in contrast with the collectivised Europe: a low threshold for the group, and a low level of *human hazards* around RF transmitters. The US culture of risk is different when it comes to 'direct' human health risks, as opposed to more theoretical risks (from cellular base stations or broadcasting transmitters) and to environmental change[47].

Within Europe, there is a distinction: UK is less regulated than France. The British Ofcom is managed mainly by economists, the French ANFR by engineers and the FCC by lawyers. The EU directives are more liberal than most national regulation; EU is leading market-based policies in Europe. In regulating electronic communications and uncertain risks, it seems easier to approve liberal regulation in the European Parliament than in the national

[45] George Bernard Shaw ‘England and America are two countries divided by a common language’.

[46] The external observers list appears in Appendix A to the thesis.

parliaments. It would be interesting to study which of the liberal forces are dominant in the EU, while less influential in European administrations[48]. The chosen RF regulated objects are distinctive; more research is needed to find out if the same patterns (EU versus US) appear in other scarce resources (water, land, and gas), other services of economic interest (transport and energy) and the regulation of uncertain risks.

The tables of comparison provide a framework for contrasting the central-planning Europe and Ecuador with the market-based US. The differences can be explained also by the judicial process and legal origin. The *civil law* is predominant on the European continent and in Ecuador; in the US and UK the judicial system is based on the *common law*. The *civil law* may favour collectivism and intervention, while the *common law* favours individualism and efficiency. The material from the RF allocation and licensing in the UK, France, the US and Ecuador provides an indication for an earlier model. These tables inspire tables 2-2 and 2-3 in the *Theories* chapter; the *Discussion* chapter uses the tables to categorise the empirical results.

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[47] E.g. US consumer standards are very restrictive relative to Europe in regards to food.

[48] In the GSM discussions, 20 years ago, the politicians pressed engineers to accept the harmonised standard.

7 Conclusion: *Case Studies*

The UK is a mediator, with one foot in America and one in Europe: UK strictly implements the EU telecommunications directives, with an American market-based style. UK is a key player in EU, but with no strong sense of belonging to the EU federation; UK harmonises its RF spectrum with Europe but keeps its sovereignty in foreign affairs and defence. The US and UK share similar views on the free market; their interpretation of the law and wireless regulation is similar (rooted in the *common law*): the spirit of the law seems more important than the text itself. Ofcom and FCC have both converged telecommunications - wire and wireless, and broadcasting – both in content and transport. These views are reflected in EU regulation and CEPT organisational changes, through the UK's contributions to these. The UK affects European regulation from inside and mainly influences the Commonwealth countries.

France is a dominant country on the European continent, with a centralised top-down and hierarchical administration. After WWII, France has been the main driving force in the unification of Europe: the declarations and initiatives of the French Minister of Foreign Affairs (Robert Schuman, 1950) and the Minister of Post and Telecommunications (Edouard Bonnefous, 1955) have become milestones in the establishment of EC and CEPT. There is an influence of the French patriarchy on European regulation; a French fingerprint can be found in the European and ITU current telecommunications regulation. Traditionally France separates power; RF allocation and licensing is divided among ANFR, ARCEP and CSA; there is no convergence of telecommunications and broadcasting, no convergence of wire and wireless communications. The French, operating in a *civil law* society with detailed legislation of probably every aspect of life, are more receptive to detailed regulation than the Americans, who only require their law to tell them what they cannot do. The French wireless regulatory framework influences Francophone countries. With a relatively large workforce, ANFR leads engineering activities in EU, CEPT and ITU-R. As the initiator of an integrated Europe, France takes a central role in the unification, by leading regulation and standardisation.

The US has been implementing deregulation and a free market policy for many years. The communications policy is set by NTIA and the FCC executes rule-making. As one sovereign federal state, it serves as an example to Europe: economies of scale, one free market, minimal intervention, industry support, public consultation process and centrality of the individual. The key difference to Europe is the basic US approach property ownership: the RF resource belongs to the public. USA promotes new technologies and innovations; its telecommunications regulation is mainly bottom-up, formed by consumer needs. A vast country between two oceans, bordered by countries (Canada and Mexico) that follow its regulation, the US applies an independent telecommunications policy, driven by market forces. A key difference between the evolution of the US and Europe's telecommunications is that in UK and in France (and in every European country) the government (i.e. the PTT and national broadcasters) operated the telephone and broadcasting services, whereas in USA private firms operated it from the first moment. The US Regulation and standards influences Latin America and many wireless regulators around the world. UK and USA promote the ‘light-touch’ licensing and refrain from excessive RF regulation. Many countries (like Australia, Ecuador, Israel and New Zealand) integrate European and US influences.

Regulation in developed countries is simpler: there is one body Ofcom in UK, NTIA and FCC in USA, compared to four regulators in the developing Ecuador (CONATEL, SENATEL, SUPTEL and CONARTEL). Ecuador is typical of South America and other tropical countries worldwide; it still remains a part of the tropical developing status ring. Ecuador's culture and social reality are different to that of the UK, France and US. The main problems in Ecuador's telecommunications are that there is too much regulation and too many regulators. It seems that there are too many engineers and lawyers and too few economists involved; economists could increase competition in order to decrease prices and increase customer satisfaction. UK, France and the US chose to separate the authorities regulating the military and civil RF spectrum; in Ecuador CONATEL is responsible for the civil and military RF spectrum.

The exploration of the *case studies* is followed in the next chapter by further research on RF rules and standards worldwide (*Indicators* chapter), in order to discover how Geography (continent and distance from the Equator) and Culture (language, religion and legal origin) influence the RF wireless communications (cellular penetration), societal and risk concerns (RF *human hazards* and *spurious emissions*) and the adoption of RF standards (TV and Cellular).

Chapter 4 *Indicators*: A Cross National Study of Wireless Regulation and Standards

Contents

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Preamble

The regional analysis carried out in this thesis and the *case studies* examined provide the techniques for understanding the regulatory framework for wireless communications and societal concerns of other inter-government organisations and administrations. The common denominator of all the studied countries is Christianity and the desire to serve the consumer benefits; moreover, the *case studies* in the research deal only with western and western-influenced countries. The difficulty with the study of Europe, EU (European Union), South America, Andean Community, UK, France, USA and Ecuador is that it does not cover Socialist countries (the former USSR), the Far East (China, India, Japan and South Korea) and the Arab countries. The *case studies* on RF allocation and licensing detail the regulatory framework, societal concerns and risk in various cultures. A thorough examination of EU and *CAN* (*Comunidad Andina de Naciones*)[1] states including their interaction with other super-national organisations is pertinent to this chapter. The *case studies* highlighted the dominance of the two diverse spheres, EU and the US, on RF allocation; the European CEPT[2] was compared to CITEL[3] (the Inter-American Commission of Telecommunications), and the EU regulatory framework was contrasted with that of *CAN*. The risk tolerance of the US was compared to that of Europe, in licensing uncertain risks, such as permitted RF *spurious emissions*, RF bands and powers for licence-exempt devices (Short Range Devices, SRD). The significant worldwide geopolitical influence of the US, UK and France on wireless communications was one of the main reasons these countries were chosen for detailed examination. We learnt from the *case studies* that as a result of the EU, there is no standardisation at a national level in Europe, even for wireless powers like France and UK. The supra-national organisations (such as EU) bound the national regulators; countries follow a regional pattern that effaces cultural influence; national sovereignty in wireless regulation and standardisation is blurred.

The *case studies* highlighted different regulatory frameworks for wireless communications, according to the diverse societal and risk concerns of each country studied. The influence of geography (Latitude and Longitude), the tropical underdevelopment, cultural variance, colonial heritage and geopolitical influence were emphasised. The differences between regulation in the developed and developing worlds were indicated, as was the distinction between countries applying *common law* versus *civil law*. The *case studies'* analysis contrasted the central-planning versus the market-based approaches.

It is important to place the *case studies* in a worldwide perspective, since *case studies* alone

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[1] The Andean Community associates: Bolivia, Colombia, Ecuador, Peru and Venezuela (resigned in 2006).
[2] CEPT: *Conférence Européenne des Administrations des Postes et des Télécommunications*; 48 countries.
[3] *Comisión Interamericana de TELecomunicaciones*; part of OAS Organisation of American States; 35 countries.

cannot paint the whole picture and may even create a false impression. A wider view of all countries provides the perspective to understand the diversity, and to discover its roots. This chapter provides the worldwide comparative data. The different tolerability to risk is exposed in the regulation of uncertain risks and the management of RF for innovation and progress. The ‘rational’ decision (based on best technology, service and price) can be compared to the actual adoption of wireless standards, in order to indicate the exceptional countries and the *Bounded Rationality* (when the adoption seems irrational). The statistical results clarify the cross-national comparisons of culture and regulation in a general way that may be of use in further studies.

This chapter broadens our horizons in order to test the empirical material, to correlate the national RF standards and wireless regulation to national attributes; the study examines cultural and technical distinctions beyond commerce and marketing. The analysis of different wireless applications is placed in a broader institutional context that explicitly takes into account national divergence, and convergence in culture and regulatory regimes; how geography and culture shape the wireless regulatory framework is explored. This chapter investigates how the US/ UK-France/ EU wireless regulations, tolerability to risk and standards are applied all over the world. This chapter correlates a ‘thin’ description of a very large number of countries, with various RF variables, to try and discover which characteristics of a country influence the choice of regulatory style and the decisions on RF regulation. This review complements the *case study* chapters, which had ‘thicker’ information about three developed countries (key worldwide players) and one developing country. This chapter reveals the countries that apply unique standards, such as Japan. The *Indicators* chapter combines quantitative and qualitative analysis: it is a quantitative examination, whilst being aware that the statistical data are vulnerable to challenge; they are being used as a guide, a set of findings to designate the most likely explanatory variables.

Only explanatory variables that might influence the RF regulation, regulation of uncertain risks and standards are chosen. The independent explanatory attributes are geography (the continent, ITU Region and latitude) and culture (language, religion and legal origin). The dependent variables are the cellular penetration and standards, TV standards, RF risks and advanced licensing. The uncertain risks explored in this chapter are the RF *human hazards*, RF permitted *spurious emissions* and innovative regulation. The introductory RF section and the *case studies* detail the specifications of the RF standards, emission limits and the influence of geography and culture in Europe and South America; figures and paragraphs from those sections are referred to, but not repeated here.

1 Indicators: Geography, Culture, Standards and Thresholds

The *master-data* is updated to 9 January 2008. Following the lessons of the *case studies* in previous chapters, the geopolitical influence of EU, USA, France and UK is highlighted in the research. Therefore, the Spanish, Portuguese, Dutch and Belgian ex-colonies and their geopolitical influence are integrated into another country's dominance or are even excluded[4]. Robin Grier (1997:51 Note 7) also excluded the Dutch, Portuguese and Belgian ex-colonies, because of the limited number of countries involved. The data is entered into the *master-data*; see Appendix B.

To avoid strong correlation (*multi-colinearity*) among the variables, a minimum number of variables are selected; however, the influencing parameters are still correlated: the language and religion are dependent factors, for example, Arabic and Islam, Spanish and Catholicism (all 21 Spanish speaking countries are Catholic). The language is strongly correlated to the legal origin (all 27 French, 21 Spanish, 6 Portuguese, 4 Dutch and 3 Italian speaking use the *civil law*). Such a link may explain a strong correlation between, for example, TV standard and language with a third factor such as colonial inheritance. Grouping columns together discloses the significant effects, but that strategy inevitably involves some loss of information. Income, Gross Domestic Product (GDP) per capita, and the development indicator were merged and grouped into the category of 'development', as they are redundant here. It would be useful for statistical purposes (minimal degrees of freedom) to use a small number of religions and languages; unfortunately, in reality that is not the case. To avoid too many ethno-linguistic and religious fragments, variables applied in less than two countries are labelled '1_2': group of one to two only; except in the case of the Russian language[5]. In this way, the analysis of indigenous languages and religions (mainly in Africa) is grouped. Language, religion and legal origin reflect colonial and geopolitical origins. In this case, the mechanism might be of 'naked power', as language and religion may not directly affect the dependent RF variable; *association* between attributes does not necessarily establish *causality*.

The language, religion, geography and 50/60 Hertz electrical supply (technically related to the analogue TV standards) provide measures and are used as proxy indicators in order to reveal the geopolitical influence. The dependent RF variables (TV and cellular systems) serve as a significant explanatory factor in revealing geopolitical influence and *Bounded Rationality*. To depict the geographical influence and an overall global regard, the data is

[4] Their data is incorporated elsewhere, e.g. Belgium is incorporated in France, if the influenced country still uses the French language, like Democratic Republic of the Congo, Burundi and Rwanda.

[5] Surprisingly, Russian is an official language only in Russia and Belarus (Belarusian); however, it is spoken in all former Soviet republics and is an official ITU language. Moreover, Russia is still dominant in their wireless regulation and standards. So RUS appears in the *master-data* as the language of all ex-Soviet Union countries.

transferred by the ArcView ArcGIS9 software to world-maps. The dependent variables (*human hazards* and *spurious emissions*) highlight the risk averse/seeking tendencies of the country. The statistics quantify the correlation of geography and culture to RF standards, and provide significance to the observed values; latitude and mobile penetration are quantitative interval variables permitting mathematical analysis. Excel® generates the charts, tables and primary statistics[6]. An empirical survey of all countries, on the analogue colour TV system, cellular standards and cellular penetration is carried out.

The statistics provide no weighting: France and Samoa are on an equal footing. Any weighting may bias the results; 'democracy' allows one vote to any observation. The use of all countries and different controlling variables provide the statistical proof for the influence of geography and culture[7]. Because of a lack of data needed to construct a meaningful series on regulating uncertain risks, the available data has been presented here on a smaller scale.

Determining versus Explanatory Factors

There are several converging variables influencing the specific wireless regulatory framework, licensing style and standard adoption. The independent attributes were selected to explore what affects wireless regulation, societal concerns and risk. This chapter correlates the adoption of colour TV system mainly to the continent, official language, religion, legal origin and membership of international organisations of each particular country. The analogue standards of the 20th century are interesting, since they were adopted before wireless globalisation and European wireless harmonisation. They preserve the spirit of the early standards and indicate differences between the original regulations, and the distinction among the adapting administrations. Geography is stable; the same applies for culture: the little evidence attainable regarding historical trends in national culture suggests that cultural change is very slow (Licht, Goldschmidt and Schwartz 2004:28). Therefore, the adoption of colour TV (about 35 years ago) is significant to study the first research question: *how* and *why* culture and geography influence RF allocation and licensing. Additional reasons for studying the adoption of analogue colour TV system:

– The terrestrial colour TV is one of the most essential wireless services. World citizens use terrestrial TV more than cellular technology, specifically during the 20th century[8];

– The colour TV system is representative; it reveals the geopolitical influence and the colonial roots of that country. This wireless attribute discloses the origin of the dominant

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6 Such as expected value, *standardised residual*, regression (linear and polynomial, second and third order) with R^2, and the *P_value* of χ^2 test.

7 Regarding cultural attributes, some nations contain more than one major sub-cultural group (e.g. languages in Belgium or religions in Germany), so a single characterisation based on a representative national sample may mislead, as there is an omitted variable; however, this problem is not significant as the language and the religion of the country's majority is used, and the large number of countries compensates the imperfection.

8 See ITU Indicators; ICT statistics. However, the specific TV penetration is not part of the *master-data*.

regulator: US invented and were first to operate the NTSC system, France invented SECAM and Germany (and UK) the PAL colour system;

— This data is available for all 235 countries; the information is accurate and updated[9].

In the 21st century analogue TV develops into digital TV. The choice of digital TV may disclose how geography and culture shape this decision. The standards for digital TV were developed by the 'triad of powers': the US, Europe and Japan. This chapter correlates the digital TV adoption to the geopolitical influence.

The cellular standard may depict the geopolitical dominance upon that country, such as that of the EU versus US. Econometrically, cellular penetration is an explanatory variable and serves as an 'instrument variable' to quantify and substitute the development indicator; the adoption of digital land mobile standards (CDMA, UMTS or TETRA) exposes the wireless development status and geopolitical influence. The RF section in the *Introduction* chapter showed how cellular penetration also influences the modulation of digital TV: higher cellular penetration (in Europe relative to North America) increases the need to be able to receive the TV signal also on the mobile cellular handset (8-VSB modulation at the American ATSC, versus OFDM at the European DVB-T and ISDB).

The analysis of risk precautions in UK, France, Europe and Ecuador (a transatlantic controversy concerning precaution) appears in the *Case Study,* chapter 3. The national thresholds of the RF *human hazards* for cellular base stations and power lines are the main attribute in this chapter used to compare the societal and risk concerns for each country. The data is based mainly on the information provided by countries to the WHO (World Health Organisation). The penetration of modern wireless regulation (such as secondary RF trading in the UK and the US) and new wireless technologies (such as Software Defined Radios) indicate innovation. This chapter relates these modern RF approaches to the primary religion and legal origin of each country.

2 National Attributes Influencing RF Standards and Rules

2.1 Geography

Geography has a role, as is universally agreed, in determining development, good governance and economic performance. Geography influences wireless regulation mainly through the continent wherein the country is located, its latitude, neighbourhood, topography and its isolation from other countries. The continent guides the membership of the country in international organisations and its communication alliances. The longitude and the ITU

[9] 131 European, African and Asian countries notified ITU of their TV system for the RRC-2006.

(International Telecommunications Union)[10] Regions (1, 2 and 3) are the predominant factors that official international regulations take into account in RF allocation. The latitude classifies between North/South America (and Europe), tropical/ non-tropical countries and the density of population, therefore the need of wireless communications and the potential RF interference.

The proximity to neighbouring countries and any electromagnetic obstacles (such as mountains) specify the capability to duplicate RF channels and the need for international coordination. Due to RF propagation, mountains require the erection of additional broadcasting and cellular masts, relative to flat countries; whereas with such mountainous geography, the towers are more visible and frightening to the public. The ground elevation may also determine the regulation: the Andes mountains of Chile make a VHF /UHF harmonisation with the *CAN* countries unnecessary. However, it is impossible to manage the RF spectrum in Germany without careful coordination with Netherlands, Belgium, Luxemburg, France, Switzerland, Austria, Czechoslovakia, Poland and Denmark. Islands like Australia, Japan and New Zealand are isolated and therefore may apply a unique RF allocation. Chile, Israel[11] and Japan are isolated both from their neighbours and from international membership, and are vertically aligned. The area of the country is important: it provides a relative isolation, at least to the inner land; large countries (such as Brazil, Canada, China, Russia and USA) may regulate their RF quite independently. Moreover, satellite communications are more efficient for sizeable countries, for example in covering them for broadcasting (radio and TV) satellite service, instead of terrestrial transmitters.

Jared Diamond (1997, cited by Rigobon and Rodrik 2004:11) points out that technologies migrate better on an East-West axis than on a North-South axis. The *case studies* upheld this claim for Eurasian countries (East-West) and the Americas (North-South)[12]. The *case studies* also pointed out the influence of longitude and latitude within Europe and America. Western and Northern Europe are more developed in adopting new technologies. North America is more developed than South America. Interesting to indicate the association of South with poverty, at least in the Northern hemisphere, e.g. 'The World Health Organization's 2002 report represents global health as a dichotomy of risks, between an alleged epidemic of obesity in the developed world and continued poverty in the South' (Burgess 2006:330). The countries in South America with a closer proximity to the US adopt the US TV standard. Two figures (2-2 and 3-4) in the *International and Regional* chapter depict the influence of longitude, in Europe and South America, on the adoption of digital and analogue TV. The

[10] The 3 ITU Sectors are: ITU Radio ITU-R, ITU Development ITU-D and ITU Telecommunications ITU-T.
[11] Israel is not member in any international organisation- except ITU.
[12] The same can be written for the North- South axis in Africa, about non-migration of technologies.

distance of a country from the Equator may serve as the preferred measure of geography (Rodrik *et al.* 2002:3); countries located further from the Equator are wealthier (Rigobon and Rodrik 2004:5). The South American *case study* confirmed that the tropical countries are less developed: from the twelve South American countries, only three (Argentina, Chile and Uruguay) are non-tropical countries, those being the most developed.

The absolute latitude is a dependent variable in the research. In comparative studies among countries, the absolute latitude is a significant explanatory variable, after control variables such as language, religion and education. The historical origins of settlers in the colonies are non-tropical; settlers seek similar conditions and weather to that which they are used (Acemoglu, Johnson and Robinson 2001:18 and last figures). Most ITU Member States are undeveloped: 110 developing, 49 least developed countries and only 31 are developed. Figure 2-1 depicts the development of each country and the status of tropical countries.

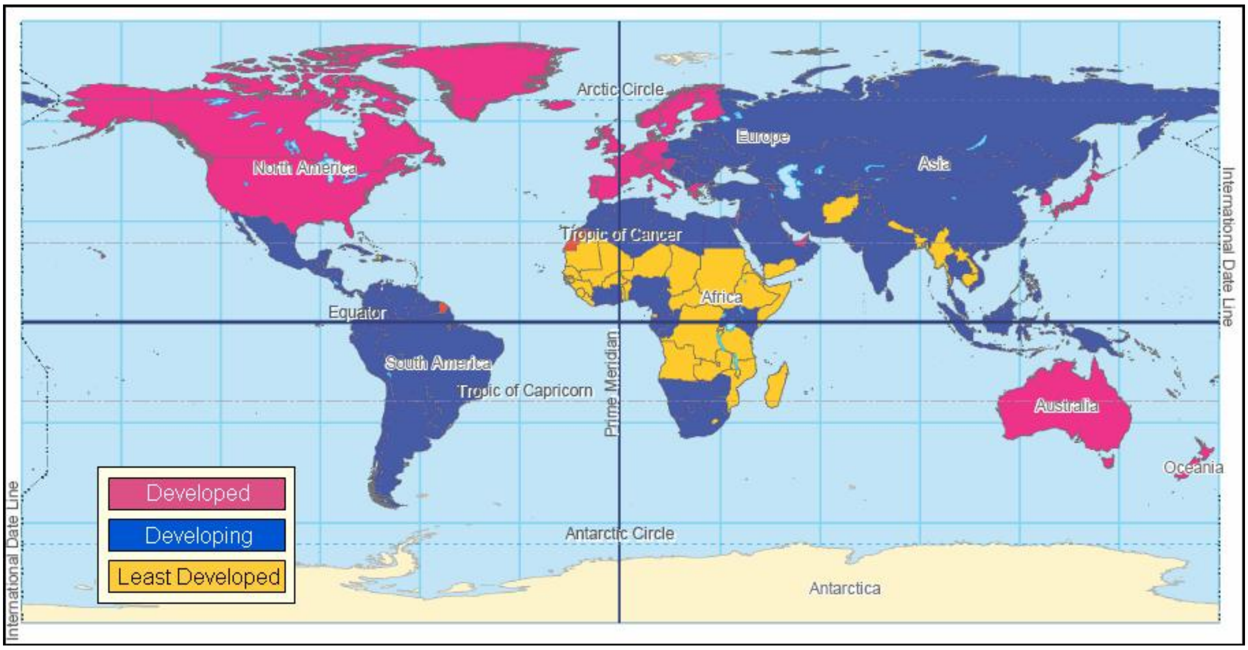

Figure 2-1 ITU development variable: Developed, Developing and Least Developed Countries

The *master-data* and Figure 2-1 illustrate the poverty of tropical countries. Out of 105 non-tropical (NT) countries only 5 (Afghanistan; Bangladesh; Bermuda; Lesotho; Nepal) are Least Developed Countries (LDCs); in comparison with 130 tropical countries (T), where only 5 (French Polynesia; Hong Kong; Macao; New Caledonia; Singapore) are Developed and 65 (half of all tropical countries) are LDCs.

Figure 2-2 illustrates that Africa is a mainly tropical continent: of the 56 African countries only eight (14.3 %) are non-tropical. North Mexico, the US and Canada and entire Europe are north of the 'Tropic of Cancer'. Countries suffering from 'Tropical Underdevelopment' (Sachs 2001:7) include Central America, and all (South American) *CAN* Countries (considered to be developing countries). Out of 235 countries, 130 are placed in the Tropics (55.3%) and 105 (47.4%) are non-Tropics.

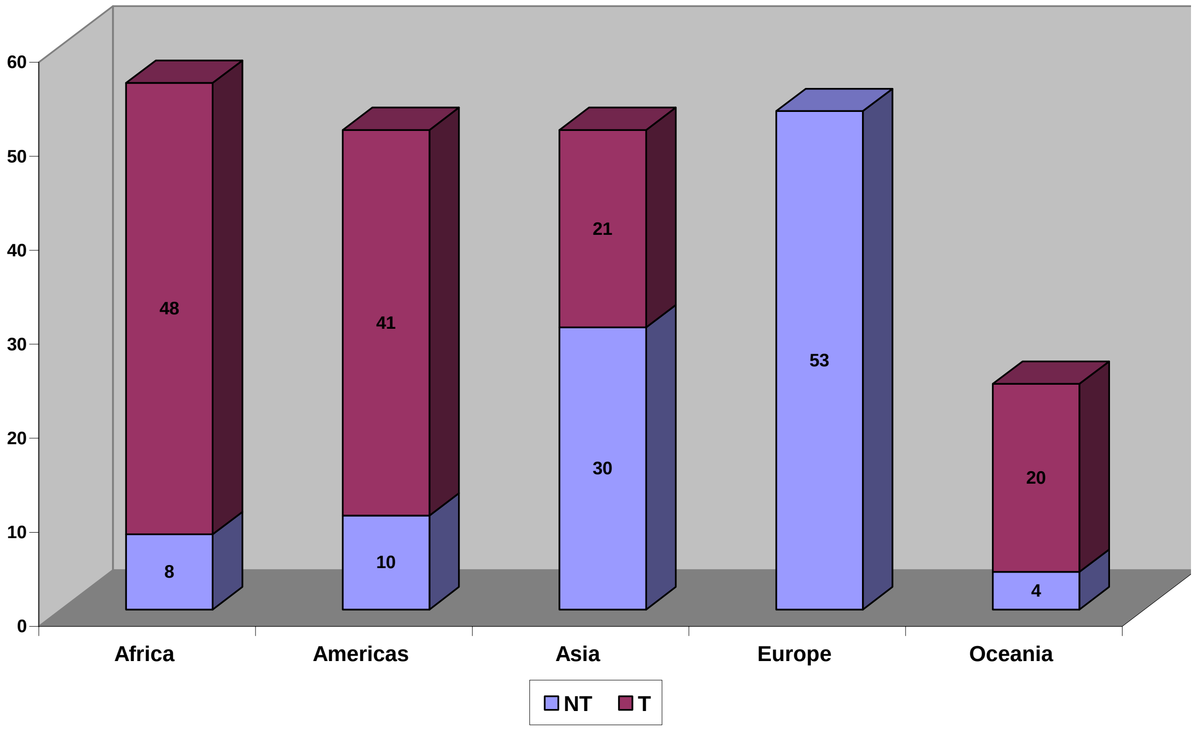

Figure 2-2 Tropical (T) and Non-Tropical (NT) countries versus the continents

The geographical latitude is also related to religion; the *case studies* showed that in Western Europe, the northern countries are more Protestant than the southern countries (being more Catholic), and that North America is Protestant and Latin America is Catholic.

2.1.1 Latitude (Tropics/ Non-Tropics) and the Legal Origin

To explain how latitude may influence wireless regulation and standards, the relationship between latitude and institutional elements is explored. The legal origin of a country might be an explaining factor. The northern part of the northern hemisphere follows the Nordic, German and Socialist legal origins; while French and English legislations are influential in French/Spanish/Portuguese-speaking and English-speaking countries, respectively. For the 143 countries (for which *master- data* includes the legal origin), the statistical analysis indicates a *significant* correlation between latitude and legal origin. In tropical countries the French *civil law* is influential (+2.1 *residual* value); the German (-2.9) and the Socialist (-2.3) legal origins are influential in non-tropical countries. These results are essential, as they correlate not only the legal origin but all the cultural attributes to Latitude; the statistics demonstrate that the legal origin is strongly correlated to language and religion.

2.1.2 Latitude and Wireless Communications

The European *case study* showed that the TV wireless reception (whether satellite or terrestrial) is linked to Latitude. The cellular penetration is a dependent wireless variable.

However, it is also an explanatory attribute of other RF systems, as it is a 'developmental indicator' directly linked to the consumption of other wireless communications and the adoption of new RF technologies. The cellular penetration also predicts the fixed phone access. Based on ITU-D data[13] from 141 countries, the cellular penetration and the fixed penetration are correlated strongly, R^2 = 0.9953[14]. The spread of wireless systems is related to the GDP per Capita; the cellular penetration and the GDP per capita are strongly correlated, R^2 = 0.6201; Figure 2-3 is based on the ITU-D data of 2006 from 182 countries[15]; it highlights the outlined countries and the *case studies* in the research. One of the two variables is redundant and as a result GDP per capita is not used in the research; the cellular percentage provides a wireless attribute (not income) to analyse the influence of latitude and the tropical/ non-tropical development.

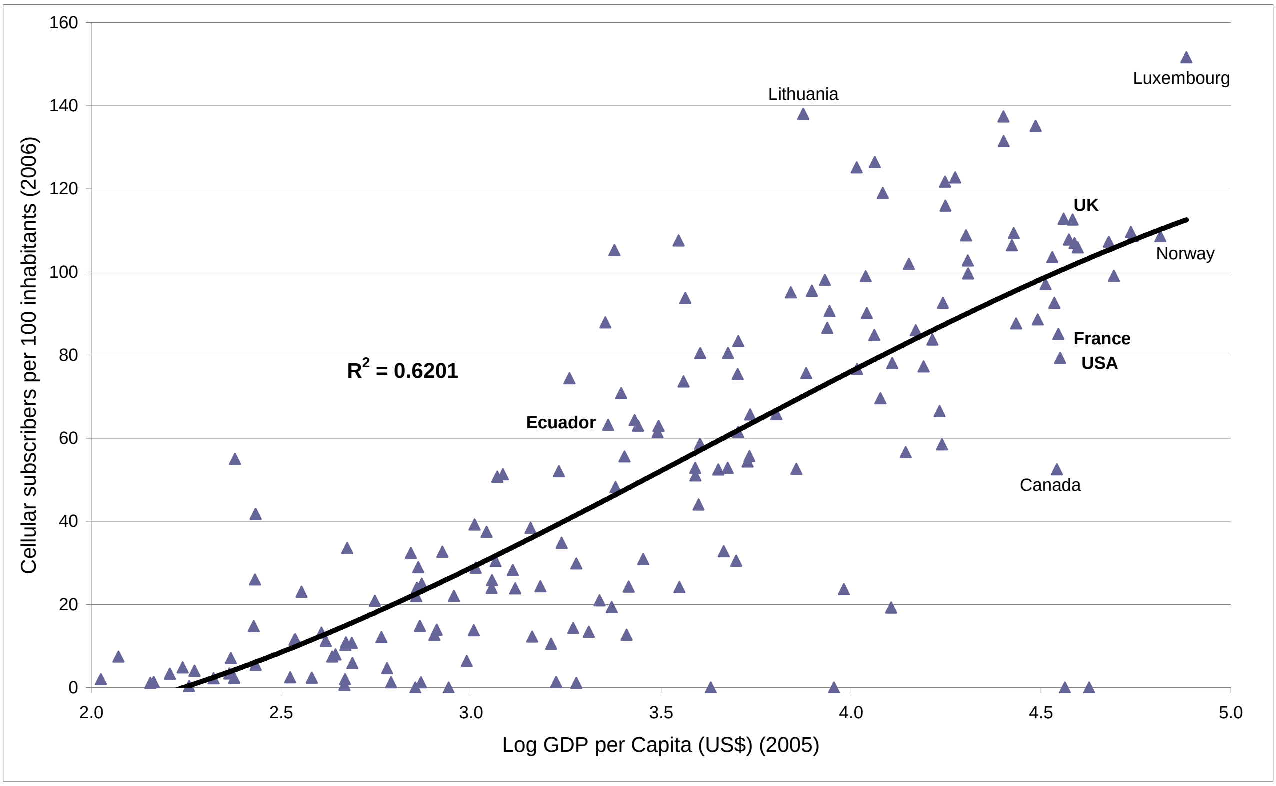

Figure 2-3 Cellular penetration versus income

The spread of Cellular and Internet per 100 inhabitants are related to the GDP per Capita. Figure 2-4 is based on the same source (ITU-D data of 2006), retrieved from 169 countries; it highlights the strong correlation. There is a demarcation of cellular penetration by latitude, since cellular penetration increases with the distance from the Equator, see Figure 2-5.

Figure 2-6[16] further emphasise the underdevelopment of the Tropics; it indicates the

[13] World Telecom Indicators Database 9th edition, Dec. 05; data in figure 2-6 refers to 2003.
[14] However, the US *case study* showed that good wired phone's infrastructure delays the cellular penetration.
[15] http://www.itu.int/ITU-D/ICTEYE/Indicators/Indicators.aspx 20/12/07.
[16] Retrieved from the data in ITU-D Database 9th edition; Dec. 05; most recent cellular penetration 2002/3/4.

development of North versus South America, Western versus Eastern Europe, the low penetration of cellular technology in the wealthy US and Canada in comparison to Western Europe; see the *case studies* for further detail. Codding (1959:104) provides a pictograph of Radio Receivers (between 1949 and 1956) per 100 people around the world. The same tropical and African underdevelopment persists; however, the comparison of the two figures highlights the growth of Chile, China, Japan, South Korea, Singapore and Taiwan during the last 50 years.

Relative Growth versus Latitude

Figure 2-5 also depicts relative growth (2006 rate compared to 2003). As the GSM infrastructure (including the handsets) is easy and cheap to install (relatively to the land-line telephones), cellular communications could reduce the digital gap between rich and poor countries; according to ITU-D indicators, the cellular telephones of the developing world has multiplied fivefold since 2000 to 1.4 billion at the end of 2005, nearly double the 800 million cellular phones in advanced economies; moreover, the cellular penetration growth of the poor countries is higher than that of the developed. Based on ITU-D data[17] from 195 countries Figure 2-5 illustrates the change of cellular percentage and depicts that the:

– R^2 [0.29 (2006), 0.3 (2003)] and Pearson's correlation coefficients [0.54 (2006), 0.55 (2003)] are approximately the same in 2006 and 2003: both regressions exhibit good statistical fit between cellular percentage and latitude;

– Intercept (with y axis) is higher (18.8% subscribers) in 2006, relative to 2003 (3.8%): in 2006 there are more cellular subscribers than in 2003, in all countries except Taiwan[18];

– Coefficient slope is higher in 2006 [1.31 (2006), 1.06 (2003)]: the latitude turns out to be more effective. Therefore, the gap in cellular percentage rises across the distance from the equator (latitude).

However, by comparing the growth rate (log of the cellular percentage in 2006 minus the log value in 2003) we get the regression $y = -0.05x + 0.52$, $R^2 = 0.0647$ ($R = 0.254$). Therefore, the relative tropical underdevelopment and the 'digital divide' North-South (in both hemispheres) **decrease**; the small coefficient hints that the decline is still small.

[17] Telecom Indicators 9th edition, Dec. 05 and lists sent from ITU-D to the author on 13 Nov. 07.

[18] 114% (2003) versus 102% (2006); in 'Serbia and Montenegro' the penetration rate was 33.8% (2003); in Montenegro the rate is only 7.8 % in 2006, while Serbia benefits 63.3%.

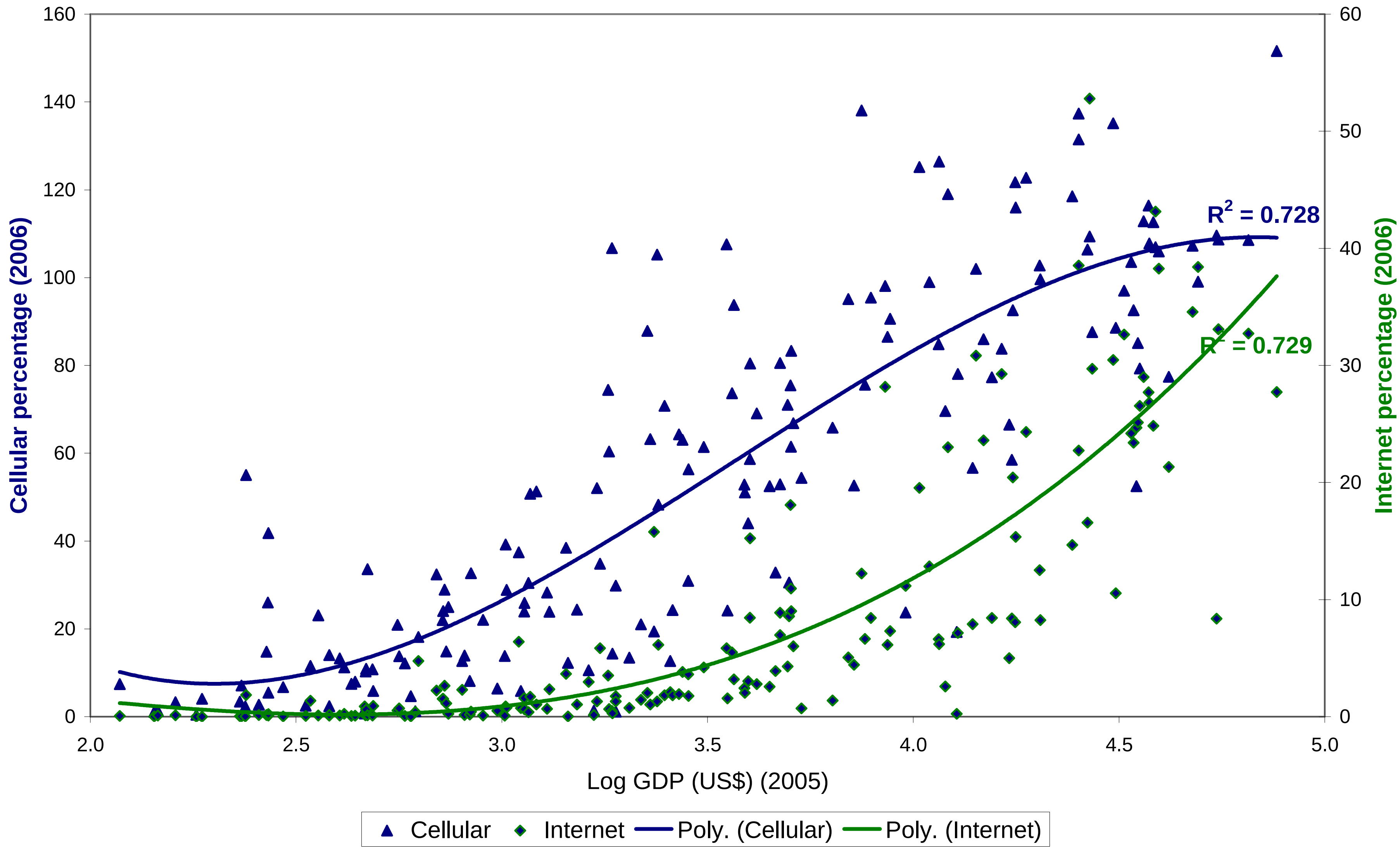

Figure 2-4 Cellular (upper graph) and Internet (lower graph) percentage versus GDP per Capita

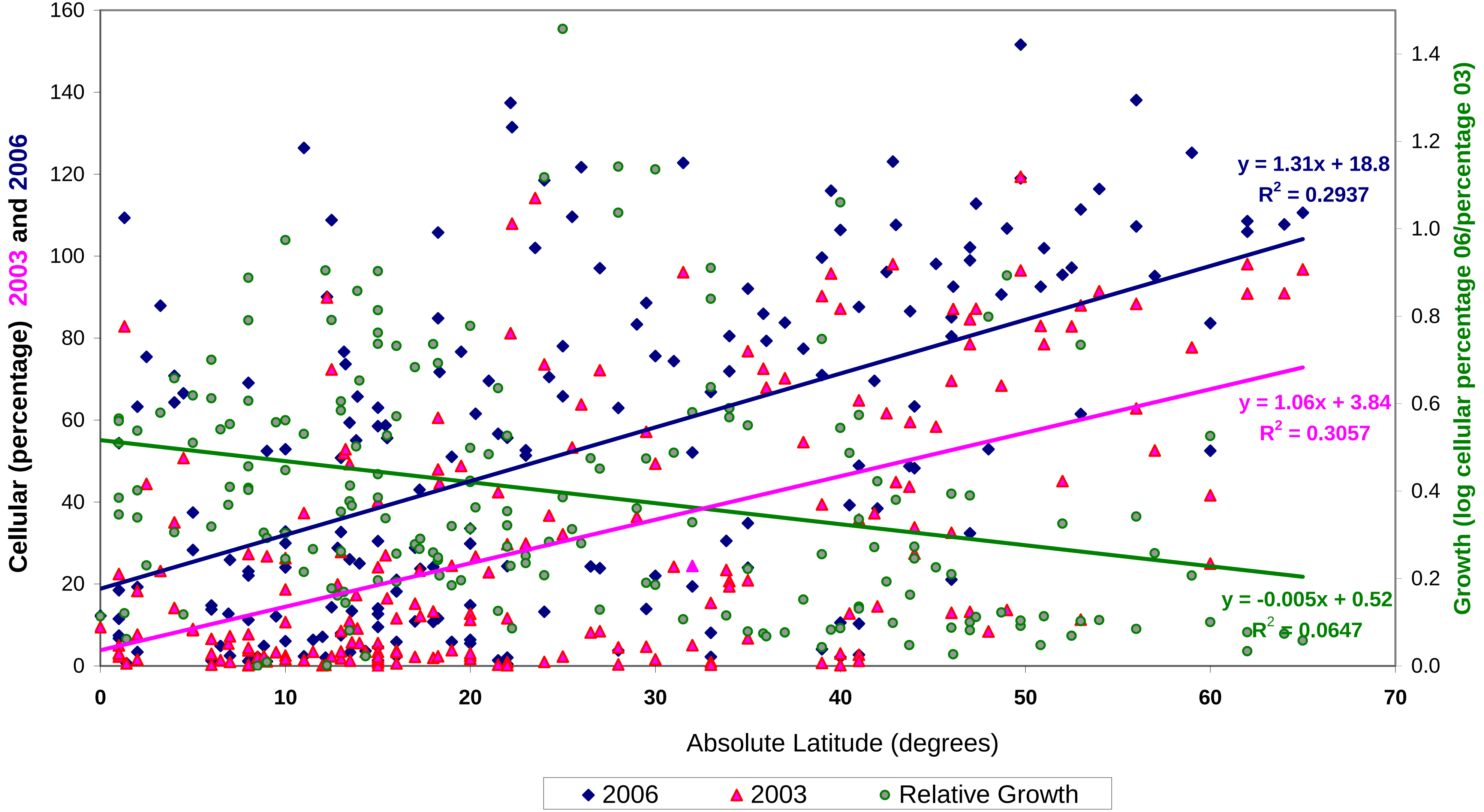

Figure 2-5 Cellular subscribers per 100 inhabitants and relative growth versus latitude; 2006 and 2003

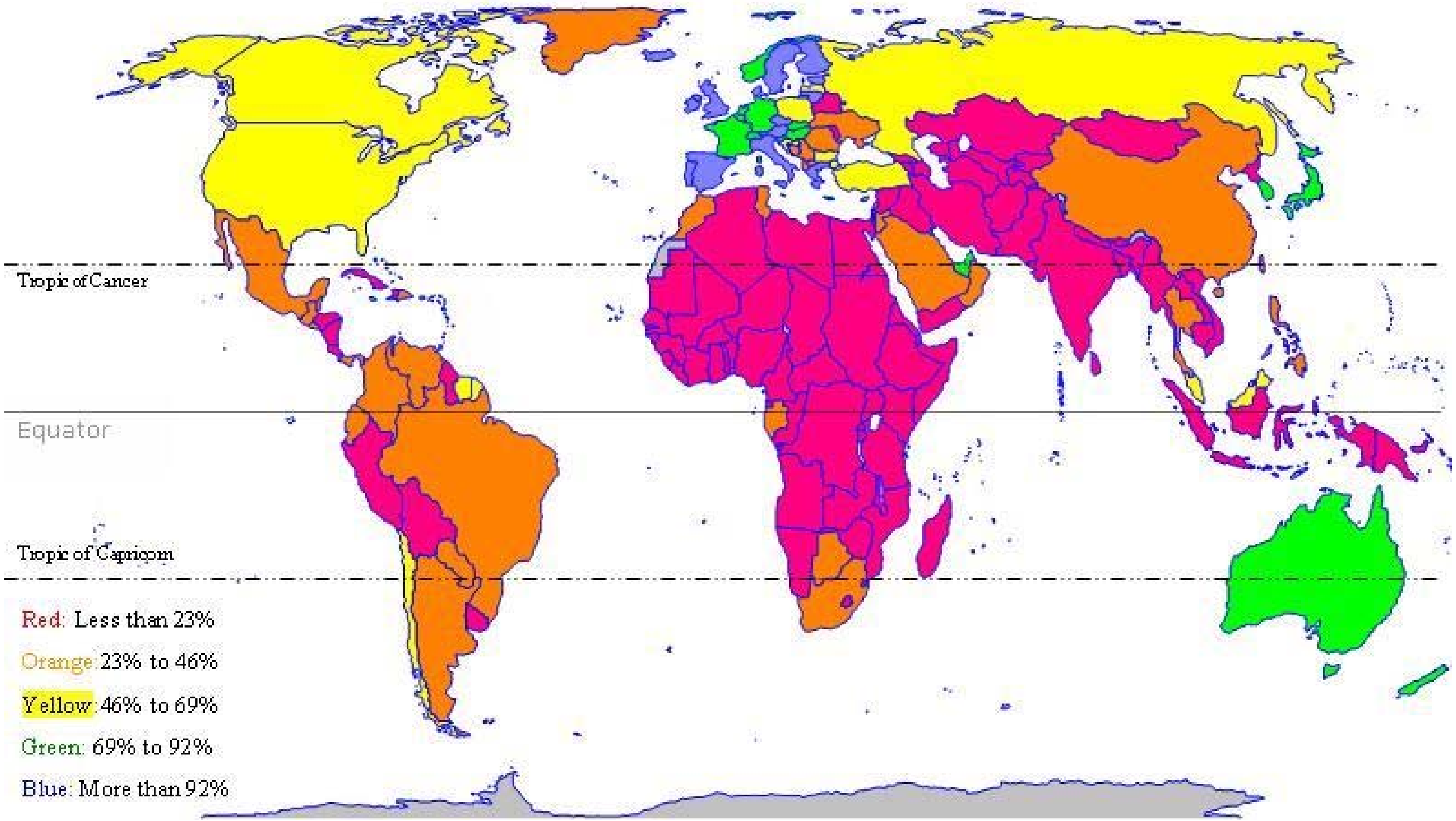

Figure 2-6 A map of Cellular penetration around the world (ITU-D data, most recent cellular penetration 2002/3/4)

2.1.3 Latitude and Wireless communications: Results' Analysis

The absolute value of the latitude band is highly predictive of cellular penetration; furthermore, the spread of new wireless technologies in countries closer to the Equator is lower. Given the varied political, economic and social histories of regions around the world, it cannot be a coincidence that almost all the tropical countries remain undeveloped. The temperate Southern Cone former colonies of Spain (Argentina, Uruguay and Chile) outperformed the tropical American colonies of Spain (Sachs 2001:10-11); the South American *case study* illustrated this. The large gap in cellular penetration between European influenced countries (such as US, Canada, Australia, New Zealand, Argentina and Uruguay) and other colonies is apparent; the rich temperate zone is opposed to the poorer tropics. The latitude may identify places where Europeans would prefer to settle (similar climate), and deploy regulatory framework and communications similar to their origin countries. The primary explanation of high cellular penetration is the GDP per capita. The European *case study* explained the success of Scandinavia and the GSM standard. Physical geography (latitude) and climate zones may expose some of the differences between North and South. The disparity of North/ South and Tropical /Non-Tropical is reflected in trade-openness, institutional quality and wireless regulation. It is difficult to discern whether it is geography or socio-economic factors that are responsible for these results. The indication is that wireless communications are related to latitude, and that latitude was significant in Unesco's pictograph of Radio Receivers per 100 people (Codding 1959:104); latitude has an effect on cellular penetration and is significant in TV reception (see the European *case study*).

2.2 Culture

2.2.1 Language

A person's culture is intimately tied to language; the language represents the internalised culture of an ethnic group. The tongue (language) is part of us. Languages may define identity: for example, Arabs are those who speak Arabic. There are six official ITU languages; Russia, China and the Arab countries succeeded in promoting their languages to a similar level of importance as French, English and Spanish; see ‘Plenipotentiary Resolution 115, Marrakesh, 2002'. The RF attributes in this chapter are correlated to each official national language; the statistical examination reveals these links. The non-indigenous languages[19] expose colonial inheritance. The English, French, Portuguese and Spanish national languages of a country reveal that these colonisers settled them. The French or

[19] These are the official ethnologic abbreviations of languages spoken in three or more countries: ARB, CHN, DEU, ENG, FRA, ITA, NLD, POR, RUS and SPA.

English-speaking countries are more exposed to the geopolitical influence of France or UK/ USA (and therefore to their wireless standards). In most countries one official language is legislative; countries speaking more than one language (e.g. Belgium, Singapore and Switzerland) echo the influence of diverse cultures.

The language is the common denominator of all Telecommunications Administrative International organisations (see the abbreviations in next section) (ATCM, CAPTEF, FRATEL, RCC), which are not regional (CEPT, CAATEL). There are no religious organisations that influence RF regulation; however, there is an organisation solely based on language- AHCIET, Spanish Telecommunications Operators. For the countries speaking one of the official languages (Arabic, Chinese, German, English, French, Italian, Dutch, Russian, Spanish and Portuguese), the author has tested whether the language is linked to the RF standards. Nevertheless, the language may create linguistic barriers (Herman and McChesney 1997:155) to adopting RF standards (and legal origins, Glenn 2004:48).

Figure 2-7 depicts the strong correlation between language and religion.

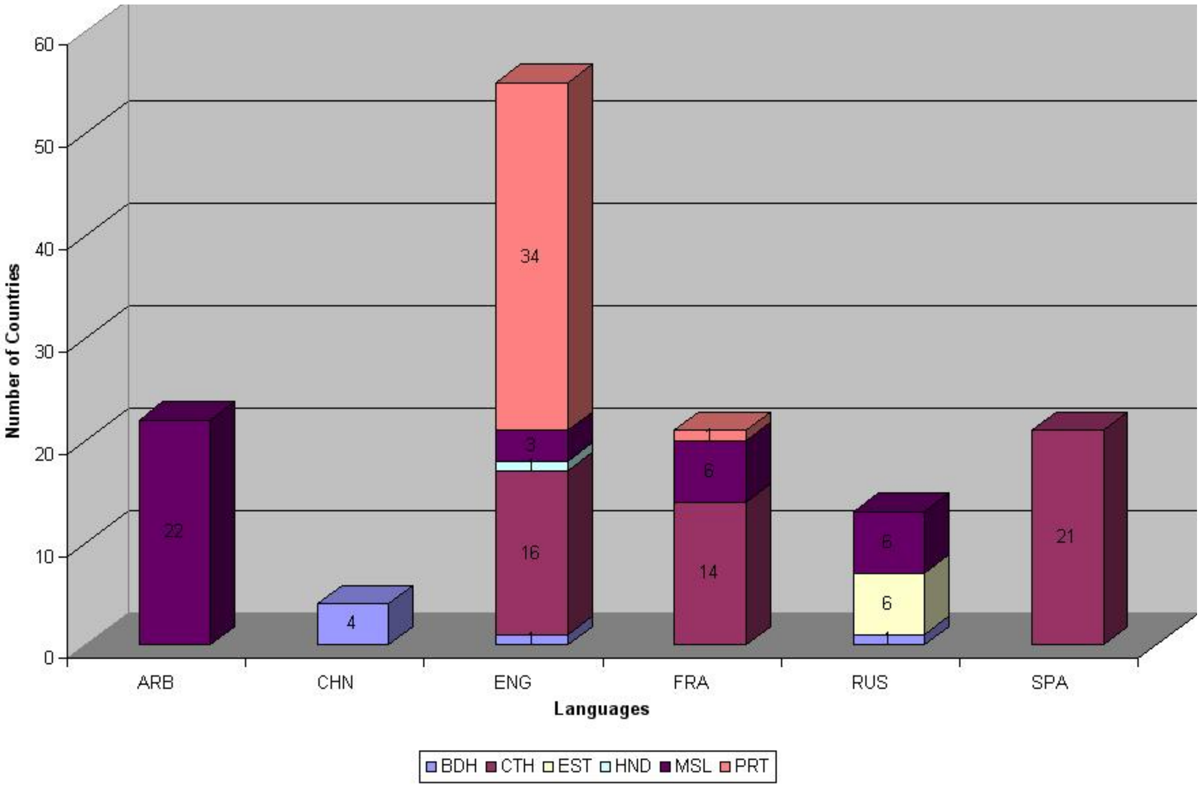

Figure 2-7 Religion versus the six official languages of the ITU

2.2.2 Religion

Risky behaviour can be linked to religion; risk tolerance varies significantly by religion (Barsky *et al.* 1997:550). Religion forms the attitude of the individual toward the superior and the sovereign (from Latin *superānus*): parents, patron, regulator, and decision-maker. Therefore, the relationship between citizen and regulator may differ according to religion.

The religion defines obedience and the moral order of society; the moral code is a prerequisite for the commercial society and regulation. Religious freedom is linked to economic freedom (Anderson 1988:1086), and therefore is a key determinant of economic performance, innovation, progress and pioneering. As religions affect the worldview, it is instructive to trace their influence on regulating uncertain risks, approach to innovation and managing for innovation. Religion may determine the country's regime, such as the Islamic Republic of Iran. Religious beliefs, identities and values are related to the colonial inheritance and geopolitical influence of a country. For instance, the Catholic countries may be more influenced by the regulation and RF limits of *human hazards* and *spurious emissions* in France, Spain and Portugal, and Protestants by UK's and the USA's rules.

Christianity may favour change; Jesus **changes** the old world; Jesus contradicts the Old Testament (against the Sabbath and respecting one's elders). Since Max Weber's famous essay (1904-5) on the effect of the Protestant ethic on national development, social scientists have linked Protestantism with economic growth and prosperity. The German sociologist claimed that Protestants seek **change** (1904-5:38), movement, hard work and progress (1904-5:45). Fanfani (1936 quoted by Grier 1997:57) states that all religions have a negative effect on development; the separation of church and state, which occurs in many Protestant countries, is the real driving force behind economic growth. Protestants differentiate between the human and the divine; this division might explain why in Protestant countries there is more pluralism[20] and an apparent separation between Religion and State[21]; Catholic France is an exception, see *case study*. The Protestant Baptists consider the Scriptures to be a sufficient and exclusive rule of faith and practice; in their **interpretation**, every individual enjoys unrestricted **freedom**. The emphasis on individual's freedom (and property rights) in Protestantism is contrasted to the Egolessness (*Anatman*[22]) in Buddhism. Like others, Robin Grier (1997:53) indicates the positive correlation between the growth rate of Protestantism and economic growth. Grier 1997:49 cites Robertson on the reverse causality: Capitalism existed before the Reformation, and may have led to Protestantism. Regarding the causality of Protestantism and the regulation of uncertain risks, it may have been that the market-based rationality of the citizens led to this specific religion and thus to tolerant regulation.

The most practiced religion in each country is referred to in the *master-data*. The study links the RF standards to these religions: Buddhism, Catholicism, Eastern Orthodox, Hinduism, Islam and Protestantism. As with language, the indigenous religions practiced in less than

[20] Chojnowski (2003) reviewing Fanfani (1936), http://www.angelusonline.org/print.php?sid=443 30/12/07.
[21] In Ecuador the Catholic Church is not separated from the State; the Georgian and Armenian Orthodox Churches are connected to the political process; in some Arabic countries the Islamic law rules e.g. Saudi Arabia.
[22] 'All existence and phenomena in this world do not have any substantial reality' Buddha *ca.*450 BC/1966:588.

three countries are grouped as '1_2'. In order to study the influence of religion, Europe is chosen as a subject; the results are typical of other continents. Based on most updated data, Table 2-1 specifies the average percentage of cellular phones versus the religion in Europe.

Table 2-1 Average mobile penetration versus Religion in Europe (end 2006)

Religion	Number of Countries	Mobile Percentage	Standard Deviation	t_Value Compared to PRT
EST	12	73.4	26	-3.31
MSL	3	56.0	13	-3.29
CTH	22	98.3	25	-0.59
PRT	13	102.8	56	
Total	50	91.0	26	

The penetration per 100 inhabitants of cellular phones in Protestant (PRT) and Catholic (CTH) countries in Europe is significantly higher than in Muslim (MSL) and Christian Orthodox (EST) *t_Value* = -3.29, -3.31, respectively. The difference between the percentage of cellular in Protestant and Catholic countries (*t_Value* = -0.59) is not significant; it is less than the critical value *t_Value* = +-1.96, for 5% significance. Similar to the North/ South diversity, the causality is probably linked to income, and not directly to religion. The results may be correlated also to geography, as Northern and Western Europe are more Protestant and Catholic. Figure 2-8 depicts the table's information.

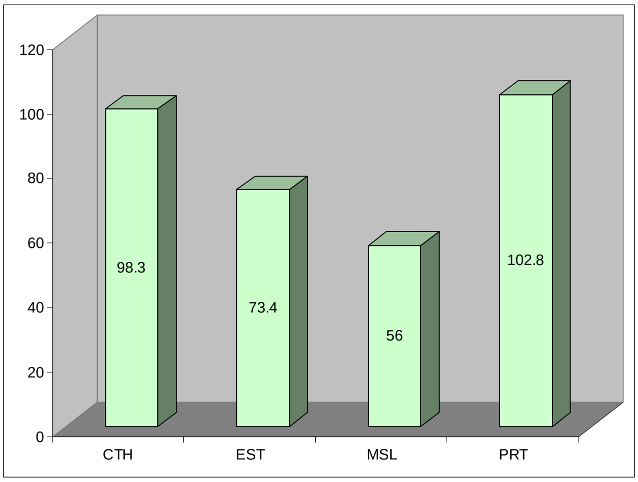

Figure 2-8 Average cellular penetration versus Religion in Europe (end 2006)

2.2.3 Legal Origin

Following the different legal philosophies, the *civil law* is the predominating legal system on the European continent, but not in the British Isles; *civil law* generally stands for the proposition that you can act in whatever way the law permits as prescribed within the text of the law. Therefore, the law must be a very detailed instrument governing all aspects of life. Constitutional and *common law* predominate in the UK and the US; the law is a limited instrument that delineates the bounds of human activity, not the details of it; see *case studies*. Continental Europeans operating in a *civil law* society with detailed legal regulation of every aspect of life would probably be more receptive to detailed top-down technological standards (such as GSM) than the Americans and British, who only require their RF regulations should be general guidelines leaving flexibility to the regulator.

Civil law is the legal system commonly used in Europe and the countries colonised by France, Spain and Portugal. The *common law* legal system forms a major part of the law established in the British territories and colonies. The *common law* was applied before Protestantism existed. The *civil law* and the *common law* may influence the present wireless regulation; the legal origin may also influence the regulation of uncertain risks, approach to innovation and managing RF for innovation. Thus, the different legislation may influence the legal reaction to RF *human hazards* from cellular towers and power-lines. Figure 2-9 depicts the strong correlation between legal origin and language.

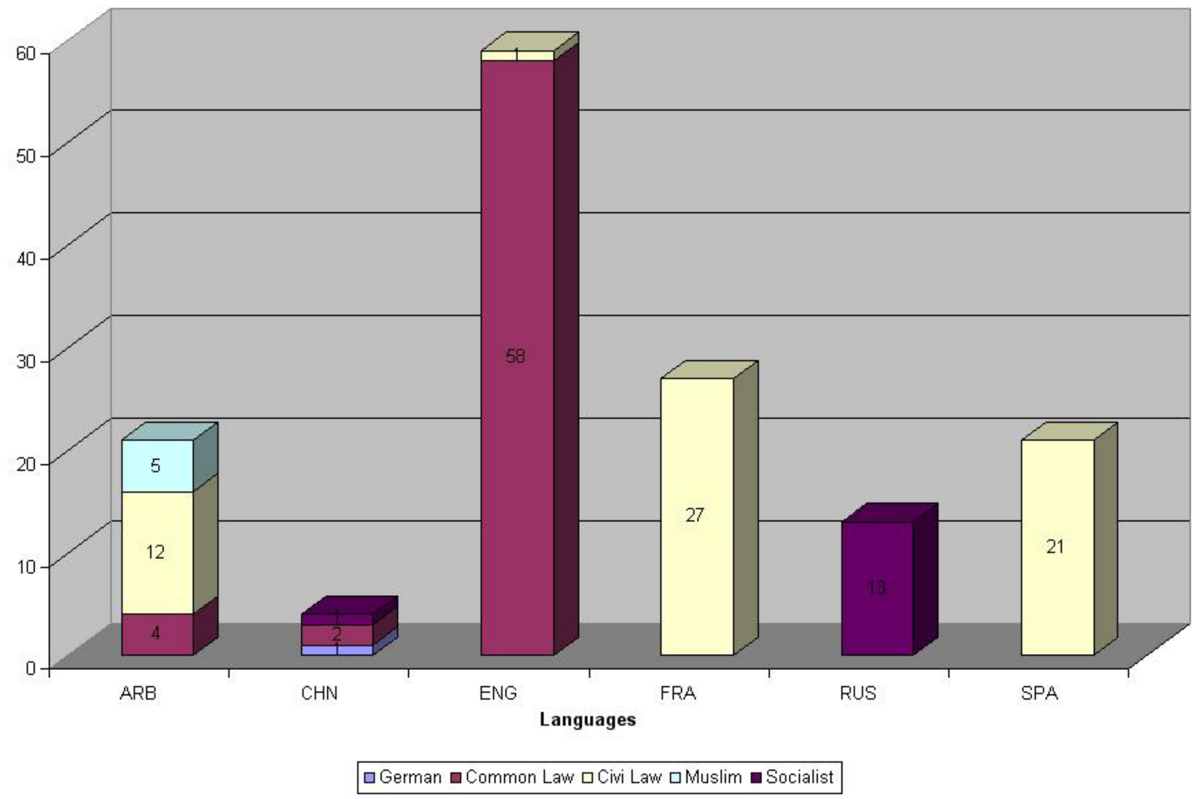

Figure 2-9 Legal origin versus the six official languages of the ITU

2.2.4 Colonial Inheritance

Similar to the present rivalry between Europe and USA, the colonial policy was driven in part by an element of superpower and economic motives. The three cultural attributes language, religion and legal origin are correlated: all 21 Spanish-speaking countries are

Catholic and apply the *civil law*; English-speaking countries are Protestant and apply the *common law*. The colonial power explains the strong correlation between the explanatory cultural variables. The colonial inheritance is a guide to language, religion, legislation and present geopolitical influence. At the time of decolonisation RF standards were dominated by the colonisers' companies and models (Herman and McChesney 1997:176). Colonial experience could be the source of the differences in institutions. Most countries (including the powerful colonisers UK, France, Spain, Portugal, Germany and Holland[23]) are themselves former colonies. This chapter relates to post-colonialism in the 20th and 21st centuries. The regulatory regimes of most countries are not indigenous, but are shaped by their colonial heritage. When the conquerors colonised much of the world, they brought with them their culture (laws and institutions); they settled and shaped the present public administration. After independence, many countries revised their legislation, but in only a few cases have they strayed far from the original (World Bank 2004:84).

The identity of the main colonising country is a determinant of current institutions; colonisation also has a present effect through culture (Acemoglu, Johnson and Robinson 2001:21). Life in the colonies was modelled on that of the *mother* country; settler colonies had representative institutions, to promote what the settlers desired: freedom and the ability to become rich by engaging in trade (Acemoglu *et al*. 2001:7); settlers expected the same rights as in their *home* country. An objective of Spanish and Portuguese colonisation was to obtain gold and other precious materials from America; furthermore, Spanish colonialism emphasised Catholicism, the religious mission, and the hierarchical role of the State. Spanish-speaking countries inherited characteristics of Spain, such as a hierarchical, authoritarian government and religion, a disdain for punctuality and the work ethic, and the lack of public spirit (Grier 1997:47, quoting Andreski 1969). These characteristics are not conductive to growth and development[24]. In contrast, the UK promoted infrastructure, industry and market forces. Latin America in general follows the US RF allocations (see *case study*); however, the regulatory style is more Spanish (Catholic, *civil law*), and different to the Protestant, *common law* approach of US/ UK: with free market forces, free circulation and minimum intervention. The colonial influence of Spain and Portugal is not reflected in the RF standards (see *case studies*); their post-colonial influence might be indirect, through the institutional relative underdevelopment of Latin America, compared to North America.

2.2.5 Mains Electricity and Left/Right-hand Driving

The national electricity system (220 Volt/ 50 Hertz) is another explanatory variable in the

[23] They were colonies of the Roman Empire; Australia, New Zealand and USA are British ex-colonies.
[24] This does not contradict the fact that Spain is one of the 10 richest countries in the world (106.4% cellular).

study; it is also attributed to post-colonialism. The 50 Hertz current is usually combined with 220, 230 and 240 Volt; 60 Hertz with 100, 110, 115, 120, and 127 Volt. Different electricity systems worsen free circulation of equipment; end-users in the 220Volt/ 50 Hz hemisphere require an additional transformer in order to operate 110Volt/ 60 Hz equipment (and vice-versa). It is another dependency on the existing standards and sources of wireless equipment (Europe versus America). Moreover, the 50/60 Hertz system is linked directly to the 25/30 frame difference in analogue TV systems. Therefore, the decision to adopt a black and white TV system, analogue TV colour standard, converter set top box and then digital TV may be related to the electricity system. Figure 2-10 depicts electrical power mains currents around the world. Europe and most other countries use a 50 Hertz 220 voltage; whereas in the Americas the voltage is between 100 and 127 volts, 60 Hertz. Liberia is unique in Africa in using 60 Hz; Micronesia, Philippines, Saudi Arabia, South Korea, Taiwan and South Japan use 60 Hz which reveals the US influence.

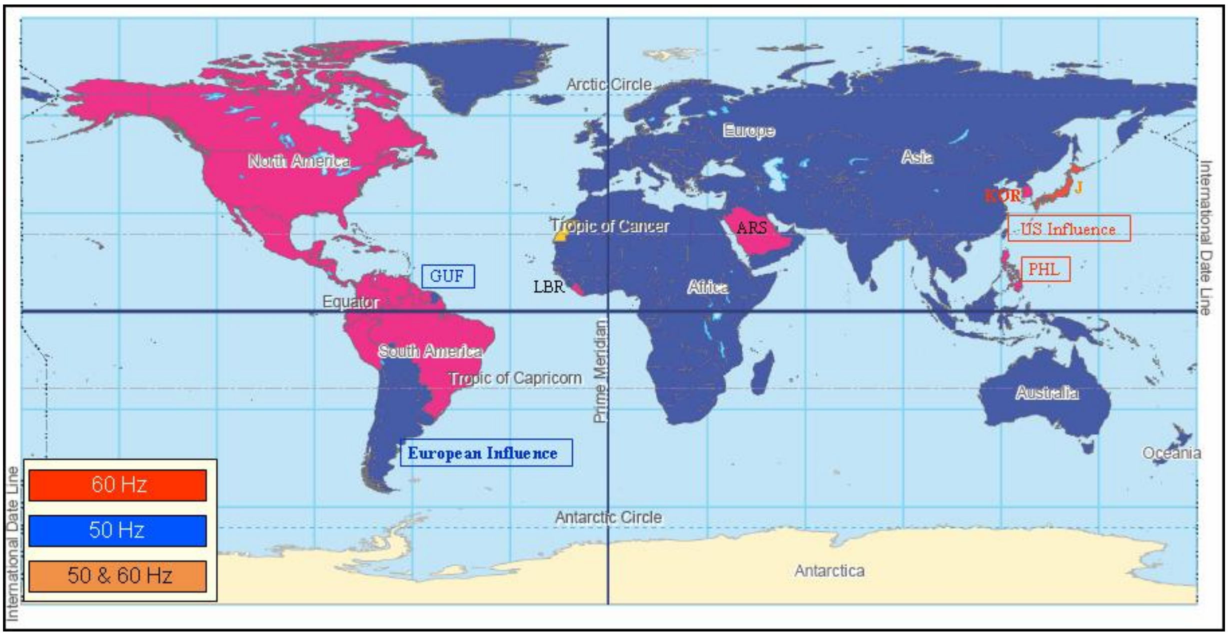

Figure 2-10 Electricity Cycles (50 and 60 Hz) around the world[25]

Left/ Right-hand driving is also a cultural element; together with the national electricity system it serves as an indicator to differentiate between English-speaking countries in order to identify their colonial origin, whether from the UK (left-hand) or the USA (right-hand). Crossing borders in left to right-hand driving also changes the colour TV standard: moving from Thailand to Myanmar, the TV standard changes from the UK (left-hand driving) PAL system to the US (right-hand driving) NTSC; from Uganda to Congo (Kinshasa), the TV standard changes from the UK (left-hand driving) PAL to the French (right-hand driving) SECAM; and from Pakistan to Afghanistan, the TV standard changes again from PAL to

[25] Original figure, retrieved from *master-data*; based on http://users.pandora.be/worldstandards/electricity.htm 30/12/07.

SECAM. The Caribbean islands that became independent from the UK in the nineteenth century (Cuba, Haiti, and the Dominican Republic) drive on the right, while Jamaica (decolonised in 1962) drives on the left. Barbados is different from most countries, with conflicting UK/US influences: a sovereign ITU Member State, an ex-British Caribbean colony, driving on the left-hand side (UK) and operating NTSC (US) colour TV; but, using the US Dollar as official currency, the US +1 international dialling code, applying 115 V (US) (and 50 Hz, UK) electricity currents. Like Barbados, Mauritius is also instructive: all countries that drive on the left-hand side use PAL; Mauritius is the only SECAM-using country to drive on the left (or to speak English, see subsection 3.1.2); out of 59 countries, Mauritius is the only English-speaking country to use the *civil law* (with elements of English *common law* in certain areas).

2.3 Geo-Political Influence

Geopolitical influence is an overarching indicator of post-colonialism and present power. This factor might be derived from the cultural attributes of language, religion, legal origin and colonial legacy. The previously dependent variables - wireless standards: colour TV, digital TV and cellular - become explanatory factors of the geopolitical influence. Moreover, the geopolitical influence may cluster the states and significantly explain the RF standards and licensing framework. After the RF harmonisation in Europe, this changed; the unique wireless regulation of any European country became scrambled in a super-national Europe, overriding and blurring the sovereignty of states. However, the national regulatory styles, societal and risk concerns remain different. The historical direct influence of UK and France on wireless standards (both in Europe and worldwide) appears only indirectly, through CEPT/EU regulation and ETSI standards. Eastern European and ex-USSR countries have gradually changed their regulation and standards: in 2007, Eastern European and ex-USSR countries follow the EU regulation in general; while during the 20th century, they had implemented Russian standards. The geopolitical influence can be separated into two periods, the 20th and 21st centuries: before the Single European Act[26], before the massive privatisation of e-Communications in Europe (and the world) and before the partition of USSR (1992); and after the era of European unification and digital communications. These periods also designate the shift from the analogue standards of the 20th century (such as analogue colour TV) to the digital systems of the 21st century (such as UMTS, CDMA2000, DVB-T, ATSC and ISDB-T technologies). There is a shift from the US' and Soviet Union's global governance toward another dual-power world: the US and Europe are taking the lead in wireless regulation and standardisation.

[26] In 1986- to bring out the single market; see the Telecommunications Terminal Equipment, TTE 86/361/EEC.

EFTA countries (Iceland, Liechtenstein, Norway and Switzerland) follow the EU regulation, without being part of EU; for example, EFTA countries implement the R&TTE Directive.

The *case studies* demonstrated that international accords pull countries more closely into the global as well as regional systems, reducing the freedom of the relevant regulators in adopting standards. The membership of a country in an organisation also discloses its global view on the one hand, and influences its decisions on the other hand. Internally, it is easier for the regulator to justify the rules (such as *human hazards* threshold), referring to the decisions of the regional organisations. The membership of super-national and international organisations in addition echoes the geopolitical influence. The participation in organisations works in two ways: the influence of the Member State on decision-making within that intra-national organisation, and implementing its rules. Table 2-2 specifies the international organisations that make up part of the *master-data*; not all of them hold an equal power.

Table 2-2 Main international administrative organisations influencing wireless regulation

Name	International Organisation
APT*	Asia Pacific Telecommunity, 25 countries
ATCM[27]*	Arab League, 23 countries
ATU*	African Telecommunications Union, 44 countries
CANTO	Caribbean Association of National Telecommunication Organisations; 27 countries
CAPTEF[28]	Administrative conference of Posts and telecoms of French speaking countries, 22 countries
CEPT[29]	European Conference of Postal and Telecoms Administrations, 48 countries**
CAATEL[30]	Andean Committee of Telecoms, 4 countries**
CITEL[31]*	Inter-American Commission of Telecoms, 36 countries**
CTO ***	The Commonwealth Telecoms Organisation, 54 countries
EFTA	European Free Trade Association, including Iceland, Liechtenstein, Norway and Switzerland**
ECOWAS[32]	Economic Community Of West African States, 15 countries
EU	European Union**
FRATEL[33]	Francophone Telecoms Regulatory Network, 50 countries
IIRSA[34]	South American Regional Infrastructure Integration, 12 countries**
Mercosur	South American countries: Argentina, Brazil, Paraguay, Uruguay**
NAFTA	North American Free Trade Agreement: Canada, Mexico and US
RCC[35]*	Regional Commonwealth in the Field of Communication, 12 countries
REGULATEL	A Forum of 19 Latin American Telecoms Regulators
TRASA***	Telecom Regulators' Association of Southern Africa, 14 countries

[27] Arab Telecom Council of Ministers/League of Arab States; see also Arab ICT Regulators' Network.
[28] Conférence Administrative des Postes et Télécommunications des pays d'Expression Française.
[29] Conférence Européenne des Administrations des Postes et des Télécommunications.
[30] Comite Andino de Autoridades de Telecomunicaciones.
[31] Comisión Interamericana de TELecomunicaciones; part of OAS.
[32] Also West Africa Telecommunications Regulators Assembly (WATRA); 13 of these 15 countries are LDCs.
[33] Réseau francophone de la régulation des télécommunication.
[34] Iniciativa para la Integración de la Infraestructura Regional Sudamericana.
[35] Past Russian dominance, present Russian influence.

* MoU (Memorandum of Understanding) with CEPT; ** see *case studies*; *** the membership itself reflects international relations and reveals common roots.

Generally, these organisations guide administrations toward a specific wireless policy, regulation and standards; as in the case of the Arab League's guideline to adopt the European DVB-T and GSM, and NAFTA's influence on Mexico in favour of adopting the US and Canada wireless rules. The intercontinental telecommunications organisations CAPTEF and FRATEL are another means of extending French influence mainly over African Francophone regulators. RCC reflects the Russian power; CITEL is influenced by the US and Canada. APT and ATU do not guide regulation nor influence standards (in contrast to CAATEL, CEPT, CITEL or RCC), despite the efforts of Japan and other Asian countries in APT. States are members of certain organisations and are influenced by various institutions: e.g. the ATCM, ATU and France influence Tunisia and Algeria. CEPT broadens Europe's influence in telecommunications by signing Memoranda of Understanding with other international organisations (see* , for MoU in Table2-2). As a result, *CAN* and ECOWAS have declared that the EU is a good model for their regional organisations. Australia (on Christmas Island, Cocos, Norfolk Island), China (Hong Kong, Macao) Denmark (Faroe Islands, Greenland), Holland (Aruba, Netherlands Antilles) and New Zealand (Cook Islands, Niue, Tokelau) are all influential in their own colonies; a similar influence exists also in French, UK and USA colonies (see *case studies* and *master-data*).

'The US long ago replaced Great Britain as Canada's main cultural and economic link, and in fact has gradually assumed a position of economic, political, and cultural pre-eminent influence, if not domination, over the smaller power' (Herman and McChesney 1997:156). Their wireless variables are identical, even their cellular penetration is similar. The US also influences the Caribbean Islands, close neighbours of the US. But unlike Canada the islands are tiny, and most of them have only recently emerged from colonial status - the recent wave of decolonization began in 1962, when Jamaica, the largest of 13 British Caribbean colonies, became self-governing (Herman and McChesney 1997:174). The decolonised islands have tended to evolve fairly quickly from colonial dependency on Great Britain to neo-colonial dependence on the US. Trade importance has also greatly increased since 1962 (Herman and McChesney 1997:175-6).

The international telephone country dialling codes (for example +44 for UK, +33 for France, + 1 for the USA and + 593 for Ecuador) is another indicator in the *master-dat*a; these codes disclose the geopolitical influence, geographical neighbourhood and even some "cultural domination" (the very use of this phrase is problematic). Twenty-four countries use the US ‘1’ assigned telephone code in their country; those countries are the first candidates to adopt the US wireless regulation and standards. It is interesting that Anguilla, Bermuda, British Virgin Islands, Cayman Islands, Montserrat and Turks and Caicos Islands are ‘G’ in the ITU file (and *master-data*), that is, part of Great Britain, but employ the US dialling code ‘1’. Twenty-one countries (out of 24 using the US code) are English-speaking; Dominican Republic and Puerto Rico speak Spanish and American Samoa speaks Samoan; none of the French-speaking country employs the '1' dialling code. Twenty-one countries are located in the Americas; American Samoa, Guam and Northern Marianas Islands are tropical islands in Oceania. The use of this code reveals the dominance of the US in e-Communications in Region 2, and its lack of influence on French-speaking countries (they do not adopt also American TV standards, such as NTSC and ATSC). Like the + 1 international telephone code, the US dollar reveals the US influence; interesting to note that nine of the ten countries using the US currency, operate the NTSC colour TV (East Timor is the exception operating PAL); eight countries are English-speaking; none of the French-speaking country utilises the US Dollar.

Like the international dialling codes and the currency, the transfer of power by a country in the ITU Plenipotentiary (PP) conferences (1998 PP-98 and 2002 PP-02) and World Radio Conferences (WRC-97, WRC-2000, WRC-03 and WRC-07) is significant. The transfer of power during the last decade reveals the same pattern: geographical neighbourhood, speaking the same language and geo-policy guide the decision-makers to remain in the same cluster of countries; regulators are bounded and channelled by their geography and culture; exceptions to this rule are rare.

It is important to note also the negative geo-policy: a derogatory attitude toward a country influences the adoption of wireless standards; for example, the South American countries' antagonism towards the US (the ‘Gringos’), China and South Korea against Japan, and Algeria against France. This type of *Bounded Rationality* is explained in the next chapters.

3 Dependent Wireless Variables

Audio (Radio) and video (TV) broadcasting were the most popular RF services in the 20th century. Analogue wireless systems have evolved in the 21st century to digital technology. There are only three TV analogue (NTSC, PAL, SECAM) and three dominant digital TV standards (ATSC, ISDB, DVB). This is a technical advantage for the research and for the statistical analysis. Technical details are analysed in the RF introductory section.

3.1 Analogue and Digital TV standards

3.1.1 Analogue Colour TV: NTSC, PAL and SECAM Standards

The first colour TV system was developed in the US; on 17 December 1953 the FCC approved the transmission standard, with broadcasting approved to begin on 23 January 1954. Germany and the UK began the PAL colour transmission in 1967. France created SECAM, with broadcasting starting in 1967 (as with PAL). Many countries (actually, 13 out of 61) that operated SECAM in the past are now changing to PAL (noted as SECAM^ in the *master-data*[36]), due to the abundance of professional and consumer equipment produced for PAL; e.g. East European countries Czechoslovakia, Poland and Hungary. The three colour systems required special fittings in order to be adapted to the different 50/60 Hz electricity systems. This section tracks how countries worldwide apply colour in their analogue TV systems. Out of the 235 countries, four countries do not operate their own terrestrial TV[37]. Another RF barrier among TV (analogue and digital) standards is the different channel separation that exists: in Europe it is 7 MHz in VHF and 8 MHZ in UHF, in the US (and all countries operating NTSC) 6 MHz V/UHF. Figure 3-1 depicts Colour standards operation and percentage across the continents, 231 countries; it illustrates that PAL is the most common system used worldwide; PAL and SECAM standards are operated in all continents; the Americas prefer NTSC; Europe and Africa do not operate NTSC at all.

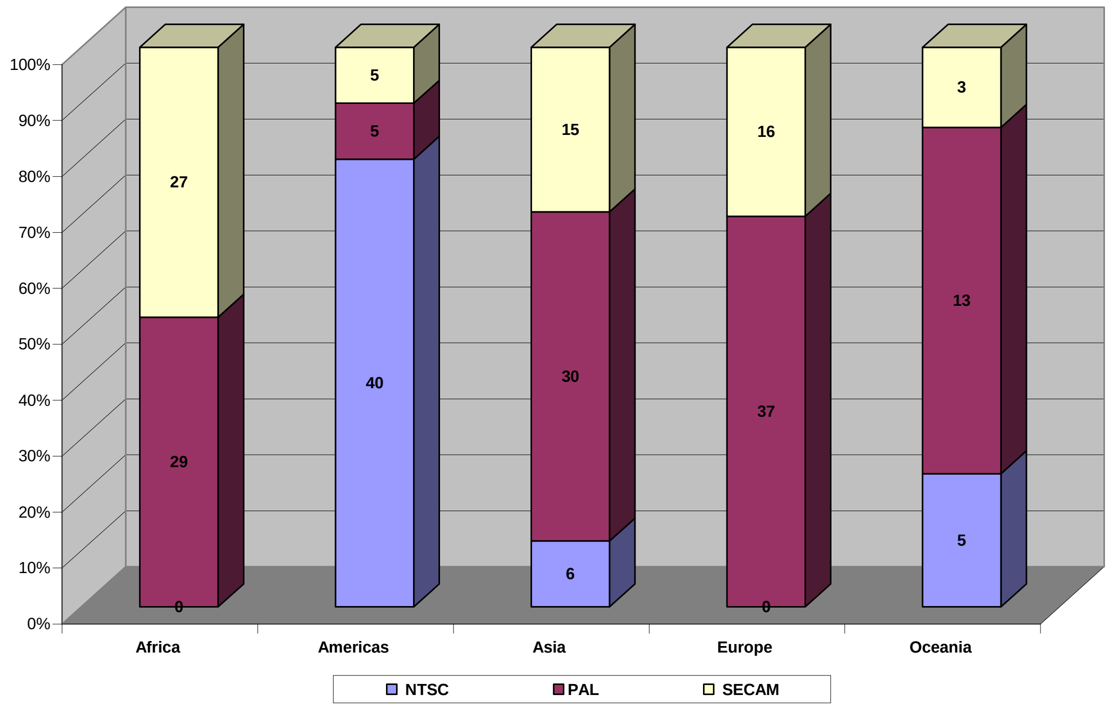

Figure 3-1 Colour TV across the Continents

[36] Statistics and graphs in this chapter refer to the original choice, so countries which operated SECAM in the past, are referred to as SECAM and not PAL, in order to highlight the colonial, cultural and geopolitical roots.
[37] Kiribati, Pitcairn, Tokelau and Western Sahara; they are red coloured in Figure 3-2: TV around the world.

Figure 3-2 shows which countries have adopted each of the three TV standards. The different clusters are well portrayed; the map highlights irregular and outlined countries operating NTSC or SECAM in East Asia (see later).

In addition to the French-speaking countries, large parts of Eastern Europe, including the former USSR and its neighbours on the other side of the Caucasus in the near East have also chosen to use SECAM. Rhonda Crane (1979:72) associates Russia's adoption of SECAM to its political alliance with France, and demonstrates that Russia carried the Eastern European bloc along with it to adopt SECAM (Crane 1979:86). There is another geopolitical reasoning for one common standard; the ex-USSR operated under a single Soviet regime, at which time the use of SECAM was agreed upon. The common regime was certainly a good reason for them to share a single TV standard, but even without it, their geographical proximity to each other made it worthwhile, so that broadcasting from one country would serve the others as well (which is also related to language). There are sound technical and practical reasons for choosing similar systems to neighbouring countries, such as similar language and interests; geography has an important influence on choice of colour TV system. Figure 3-2 (developed especially for this thesis) depicts this influence; the spatial closeness positively links the adoption of the colour TV standard. The differences in NTSC versus PAL adoption between the west and east coasts of South America were explored in the South American *case study*; see chapter 2, figure 3-4. No European country has adopted NTSC.

Some countries seem to have put other motives first, in choosing which TV option to adopt. For example, Japan, Micronesia, Myanmar, South Korea, Philippines and Taiwan have chosen the US system NTSC, rather than the PAL system adopted in the whole of East Asia (except Vietnam and North Korea). This is an indicator of strong US influence on those countries. A similar conclusion may be reached about Vietnam and N. Korea, whose unique operation of SECAM belies a Russian (not French) geopolitical influence. The origin of the influence is revealed from their Russian standard SECAM-D, not the French SECAM-L. Algeria is the only North African country to choose PAL and not SECAM[38]. In this way, although a country's geographic location is a strong predictor of the TV system it is likely to adopt, other significant forces must also be at work here, as witnessed by the division in South America, and the unusual cases of East Asia. Figure 3-2 depicts the geopolitical influence, cultural, colonial inheritance and technological preference of each country; the outline countries are well illustrated.

[38] The decision on PAL was taken in 1975 when the policy was to reject everything related to France. Based on e-mail from a TV expert from Morocco, 21 June 05; approved by informal interview of an Algerian official, on 7 July 05.

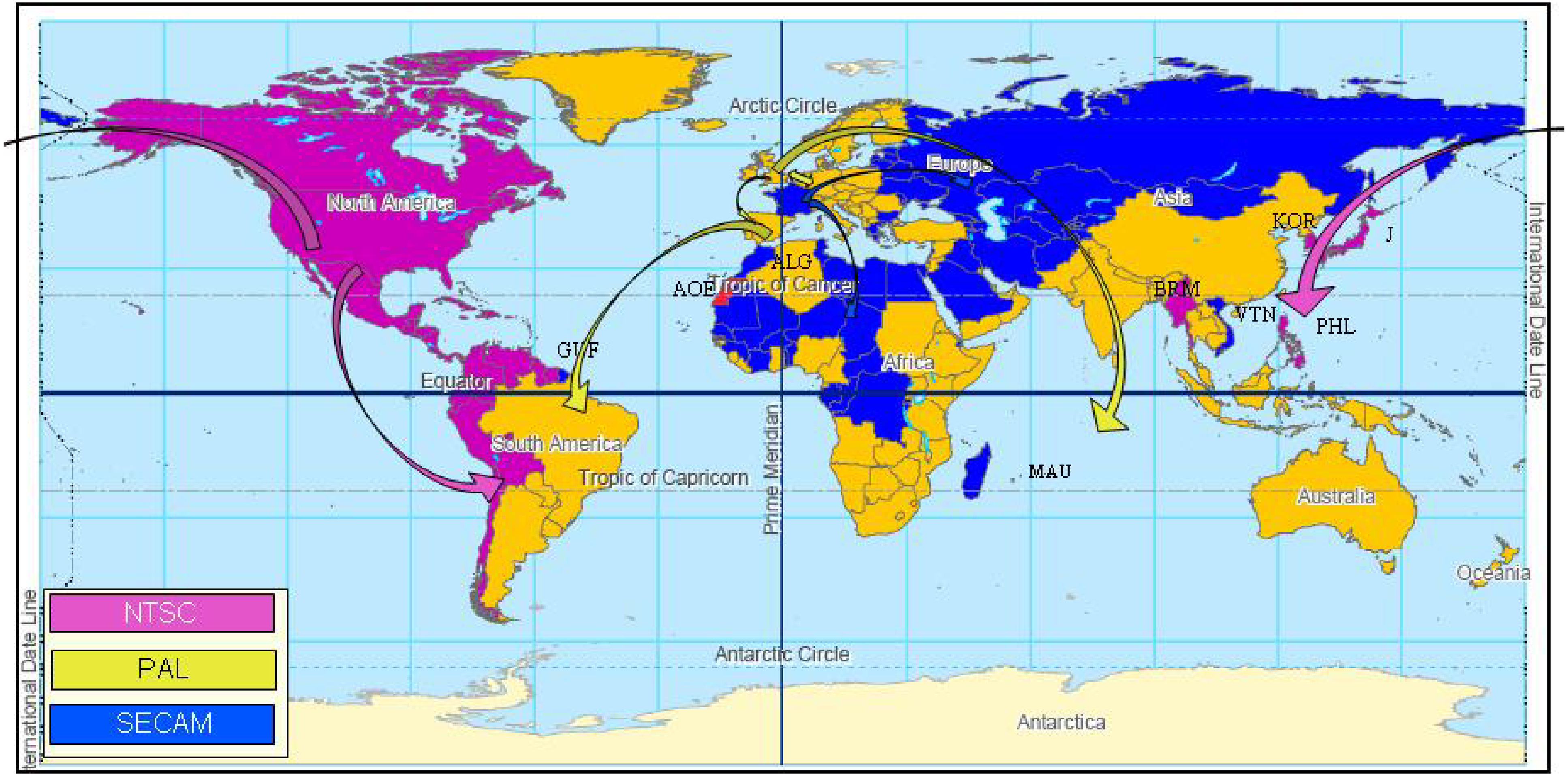

Figure 3-2 Analogue colour TV map around the World

3.1.2 Colour TV by Language

French-speaking countries adopt SECAM with a very high correlation: for the non-NTSC countries, the *t_Value*[39] in the regression is +7.47; English-speaking countries select PAL TV system.

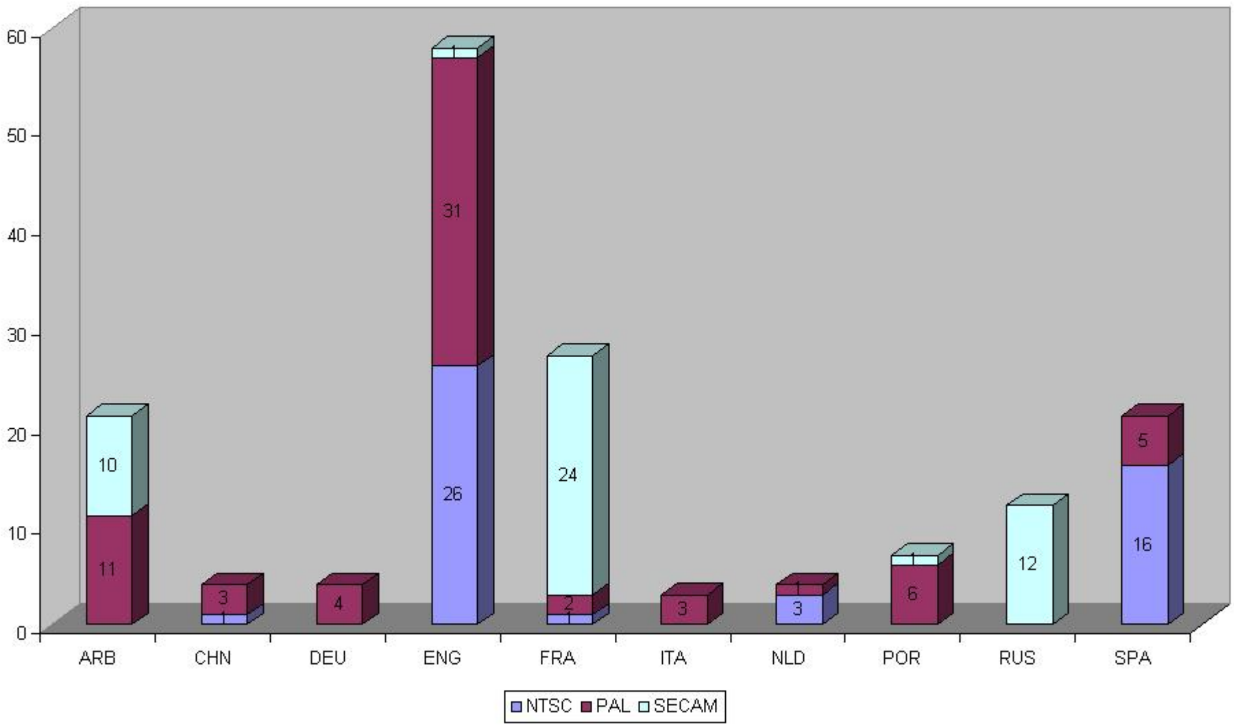

Figure 3-3 Colour TV versus Languages

Figure 3-3 demonstrates that none of the Arabic, French, Eastern European/ex-USSR countries operate the NTSC colour TV system. The SECAM countries speak mainly French; none of the 21 Spanish-speaking countries operate SECAM. Cameroon's PAL system is exclusive among its French-speaking neighbours. However, Cameroon is also a member of the Commonwealth Telecommunications Organisation; moreover, English is also an official language there and is spoken in its South-West and North-West provinces. Mauritius is the single SECAM-operating country that speaks English (see also Mains Electricity and Left/Right-hand Driving, subsection 2.2.5). The international membership of organisations can also explain the adoption of the colour TV system: out of the 183 countries operating SECAM or PAL, the Member States in CAPTEF, FRATEL and RCC favour SECAM, while CTO countries prefer PAL. Besides language, there are other factors, colonial inheritance and geopolitical influence[40], that are highly correlated to language, that might explain the relationship between TV standard and language.

Language also has another direct influence on the adoption of TV standards. In addition to receiving a signal from neighbours' terrestrial transmissions and getting similar language programs from satellites, in the past a VHS (Video Home System) machine could only function with the standard in which it was sold, as there was no compatibility among the three different VHS systems: PAL

[39] The statistical analysis is not enclosed, in order to save place.
[40] Of Germany and the UK for PAL, the USA for NTSC, France and Russia for SECAM.

and SECAM 625 (lines) / 25 (frames per second) and NTSC 525/30. For example, the consumer could not view an English VHS film, recorded in a studio with PAL VTR (Video Tape Recorder), in his/her SECAM VCR (Video Cassette Recorders); moreover, if recorded material that a local broadcasting TV station at that time would purchase or receive from the relevant country was primarily French, SECAM would be the natural standard of choice. Since the 1990s, dual- and multi-standard VHS machines have become more common, handling VHS tapes of more than one standard; but they were more expensive. Therefore, 30 years ago, only the compatible TV standard allowed the recording and viewing of certain video material of interest.

3.1.3 Analogue Colour TV: Analysis of the Adoption

The colour TV adoption is related to language, whether through global influence or commercial links: the language is the root of present commerce; for instance the adoption of SECAM through the connection to the French representatives, consultants and foreign aid. A common language increases confidence among negotiators, gives rise to openness among persons, among institutions and among states; speaking someone else’s language shows respect for his/her culture; satisfaction from 'friendliness' motivates further interaction, socially as well as economically (Greif 1994:916). Speaking the same language encourages nations to adopt a specific colour TV standard: literally, they identify with the similar cultural roots. Many French-speaking countries are influenced by France beyond the use of French standards. So it is not necessarily the people’s attitude, culture or just use of language; a *common understanding* has led them to prefer the SECAM standard. At least for France, language is inseparable from culture. The US, French, UK and Russian standards are better accepted in countries speaking their language. Moreover, ignorance of the language is a barrier to the adoption of standards.

As PAL and NTSC are operated in English and Spanish-speaking countries, only SECAM is strongly correlated to language - French. During the adoption of colour standards, nearly all TV broadcasting around the world (except in the US) was operated by the government. Moreover, before and during the telecom privatisation, about 25 years ago, leading manufacturers still had a strong relationship with their country's authorities; France promoted SECAM (Crane 1979:79); the French influence was widespread, mainly in French-speaking developing countries. This French influence exhibits itself in other areas in these countries, such as the legal origin (*civil law*). The SECAM system operating in a country reveals its French influence; the NTSC system its US influence; the most popular system PAL is being related to the UK and Germany, and is less politically ‘coloured’.

Culture does not change frequently (Licht *et al.* 2004:28). The geography, culture, colonial inheritance and geopolitical influence provide the rationale for the decision on colour TV standard. The same rationale (even if it sometimes reflects *Bounded Rationality*) may guide the adoption of the digital TV standard. Moreover, an important step in choosing between the available digital standards is to consider technically the existing analogue standards as the channel bandwidths (7-8 MHz in Europe and 6 MHz in America) are different, and a digital to analogue converter (set top box) might be needed.

3.1.4 Digital TV: ATSC, DVB-T, ISDB-T and DMB-T/H Standards

There are several digital terrestrial TV standards (and sources): ATSC (USA), DMB-T/H (China), DVB-T (Europe) and ISDB-T (Japan). Figure 3-4 and Figure 3-5 illustrate the adoption and launches of digital video broadcasting worldwide; it corroborates certain geographical and cultural inclinations. A country's choice of digital TV standard illustrates the relationship between wireless standard, geography and culture. The maps depict that developed countries have already launched a digital TV service or are in the process of testing it. Most developing countries have not yet come to a decision on this. Europe and ITU Region 1 are integrated and harmonised; in ITU Region 2 South America is not following the example of North America; Brazil has adopted the Japanese standard. Asia is not harmonised; Japan and China have invented their own standards. There is tense competition between the available standards. Figure 3-4 and Figure 3-5 show again the effects of tropical underdevelopment.

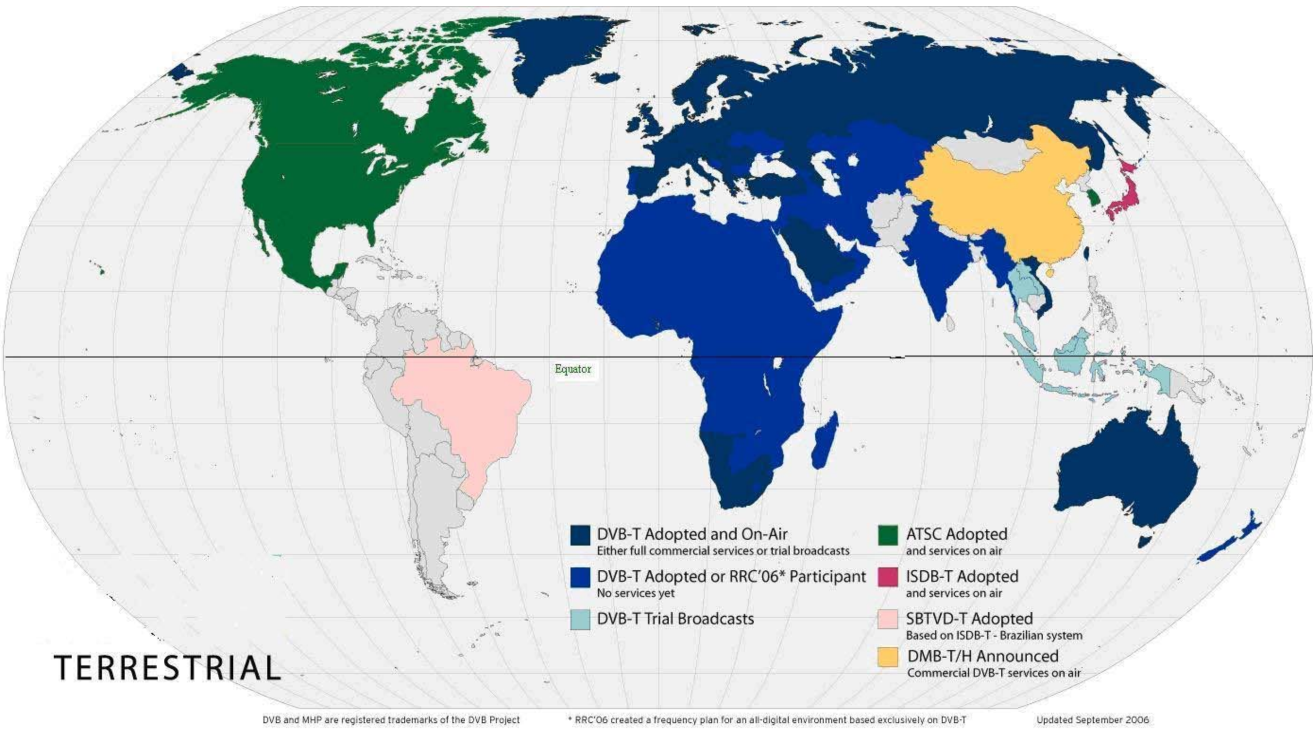

Figure 3-4 Digital TV around the world[41]

[41] http://www.dvb.org/graphics/internal/Adoption-Map_DVB-T.jpg 10/10/06; the last DVB map ever published, updated for Sept.06.

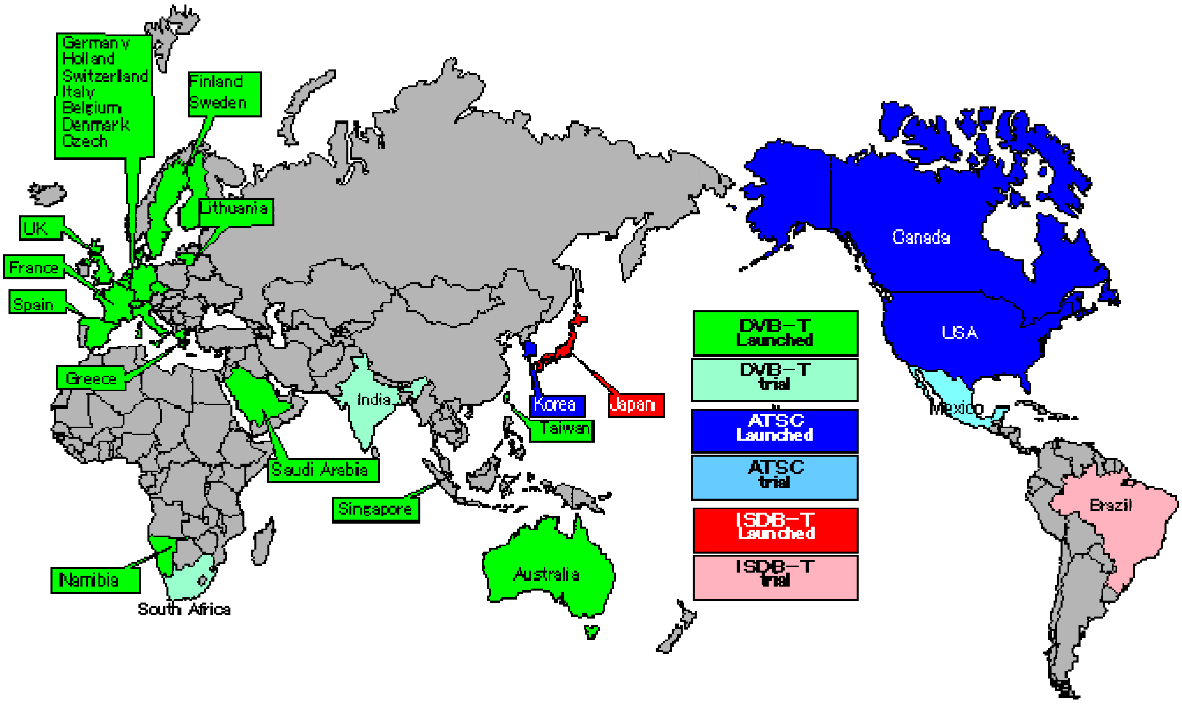

Figure 3-5 Digital TV around the world: launches[42]

"Countries that have formally adopted ATSC are Canada, Honduras, Mexico, South Korea and the US"[43]. DVB-T operates in Europe and Africa; it has been adopted by the 119 countries[44] participating in the Radio Regional Conference (RRC-06). ISDB-T operates in Japan and has entered Brazil. DMB-T/H or DTMB may be operated in China; however, this technology has so far not been successfully exported. The developing country Namibia already operates DVB-T; the system in operation in Namibia was installed by a South African Pay-TV company, Multi-choice, who already operates a subscription TV broadcasting service in Namibia; this is further evidence of how geographical proximity should influence wireless communications. Australia, Saudi Arabia, Singapore and Taiwan follow European standards; New Zealand, Malaysia, Vietnam and Thailand may adopt officially the DVB-T. Therefore countries influenced by Europe adopt the DVB-T standard. The Arab League signed a Memorandum of Understanding with CEPT[45]. It is not surprising that NAFTA (North American Free Trade Agreement)[46] countries (Canada and Mexico) operate the US digital TV standard ATSC. South Korea also prefers the US standard ATSC, to their neighbour Japan's ISDB-T (S. Korea also operates the analogue NTSC system). The former Minister of Information and Communications Dae Jae Jim 2003-2005 decided in 2005 to adopt ATSC; the present Minister Tum Hyong Rho explained to the author verbally on 9 November 2006 that S. Korea is influenced by the US standards. Argentina chose ATSC in 1998 for political

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[42] http://www.dibeg.org/world/world-j.htm 30/12/07

[43] A message from Robert Graves, Chairman, ATSC Forum 10 Dec. 07.

[44] Based on the *master-data* (updated by a list sent to the author from ITU on 16 November 07) there are 191 Member States in ITU: 120 countries in ITU Region 1, 35 in Region 2 and 36 in Region 3.

[45] Their representative declared in ITU RRC-2004 that they follow European technologies.

[46] The Canadian-USA Free trade agreement of 1988 and the NAFTA 1993 pulled Canada and Mexico more closely into the global as well regional system (Herman and McChesney 1997:151).

reasons; then president Carlos Menem (who left his office in 1999) had a very good relationship with the US; this decision is now being reassessed, as the political situation is now different; Argentina may choose another standard based not only on technical reasons, but also on geopolitics and Brazil's decision (scale economy).

Taiwan (and Myanmar) operated the American NTSC analogue standard and now prefers the European DVB-T. Taiwan's choice is significant; it originally adopted the ATSC standard in 1997, but before the ATSC system was implemented, the broadcasters in Taiwan became very interested in mobile applications; the ATSC Standard did not support mobile applications. The broadcasters urged the government to change to the DVB-T system, and the government of Taiwan decided to let the broadcasters choose whatever standard they wished; they switched to DVB-T (Huang *et al.* 2003). The GSM success promoted European technologies, increased the cellular penetration and the need of appropriate mobile TV. The introductory RF section explained why the mobile disadvantage of ATSC is the main reason of Brazil and Taiwan to prefer OFDM modulation to 8-VSB, and to favour ISDB-T in Brazil and DVB-T in Taiwan. The Taiwanese case proves that unlike ISDB-T and ATSC difficulties, DVB-T suppliers provide bandwidth flexibility: equipment operating with 6, 7 and 8 MHz channel separations; but inversely, on January 2008, countries like Singapore and Israel are reluctant to adopt ATSC, because there is not currently any 8 MHz transmission equipment for ATSC.

Another question may be posed: can Cote d'Ivoire decide based on rational choice (such as the best technology) which standard to adopt, or is it guided to select only DVB-T, due to its geography and geopolitical membership (ATU, CAPTEF, ECOWAS, and FRATEL) and RRC-06 participation? The same response stands for most countries, at least in Africa. Can Venezuela (headed by Hugo Chávez) choose the US ATSC standard? Regulators follow a path sketched by their geography, past, their present regulatory framework, their geopolitical influence and state politics.

3.1.5 Analogue and Digital TV Results

The analogue colour TV adoption is deeply correlated to the geo-policies of the e-Communications superpowers. Countries influenced in the 20th century by UK and France operate PAL or SECAM standards (respectively); they also subsequently adopt DVB-T, while the American hemisphere operating the analogue NTSC may prefer the digital ATSC standard.

3.2 Cellular Standards and Technologies[47]

In the 21st century there is a cellular convergence toward two hemispheres; two distinguished evolution paths. The European GSM is evolving into the third generation WCDMA UMTS

[47] Additional information appears in the introductory RF section.

standard, whereas the American CDMA TIA-95 is advanced to CDMA2000. The network sections (including service providers and equipment suppliers) of UMTS and GSM are similar, and the same goes for TIA-95 and CDMA2000; however, CDMA2000 remains backwards compatible with the older TIA-95, in opposite to the incompatibility UMTS with GSM. CDMA 1X is deployed in the entire Americas (except Bolivia and three Central American countries). Nigeria is the only African country to operate CDMA 1X. On 21 Dec 2005, UMTS was deployed in 43 countries, mainly in developed countries. Eastern European countries (Czech Republic, Poland and Romania) and ex-USSR (Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Moldova, Russia, Ukraine and Uzbekistan) countries adopted the American CDMA (mainly 450 MHz) technologies after 1992. This adoption may be linked politically to their appreciation of the US' actions while asserting their independence. Now, due to their Europeanization (at least for Eastern Europe), they re-farm the CDMA850 to GSM (and pan-European UMTS)[48]. CDMA is typical to America, whereas TETRA (TErrestrial Trunked RAdio) serves mainly Europe. The upper series of Figure 3-6 RF standards across the Continents' illustrate the digital cellular technologies (CDMA, UMTS and TETRA) by continents.

Driven largely by the strength of Japanese and Korean industries (and the Chinese and Indian markets), the Asia-Pacific region is emerging as the largest cellular market in the world. Egypt, Israel, Jordan and Saudi Arabia are located in Region 1, but operate mobile services in the bands allocated by ITU to the broadcasting service (806-862 MHz), due to the influence of US and its industry on those countries. Moreover, Algeria, Egypt, Kuwait, Oman, Saudi Arabia and Yemen operate CDMA- to indicate some orientation toward USA.

3.2.1 The Success of GSM

The GSM system, developed initially as a European project, is the leading cellular technology, holding more than 85% of the global market and more than 90% of all new subscribers and with 2.6 Billion[49] GSM users, in 226 countries[50]. It is an absolute success; practically all countries (except Japan, operating 3GSM UMTS; but not GSM900 MHz nor GSM850 MHz) operating cellular technology use GSM. Compared to the fragmented US technologies with only 421 Million[51] CDMA global subscribers[52] and other technologies; CDMA's market share declines year-over-year relative to GSM. In Singapore (2000), in Israel (2002), in Australia (2007), in Latin America and

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[48] E.g. Poland re-farms their CDMA 850, back to European ITU Region1 allocations, 800 MHz.

[49] Exactly 2.600 Billion on 9/1/08 http://www.gsmworld.com/index.shtml compared to 1.61 Billion on 30/12/05.

[50] http://www.gsmworld.com/roaming/gsminfo/index.shtml and https://www.cia.gov/library/publications/the-world-factbook/maps/wi-map.gif 30/12/07. W. Sahara has no TV and no GSM; other small countries in the *master-data* Nauru, Niue, Tuvalu, might not update their GSM operation.

[51] http://www.cdg.org/worldwide/index.asp 30/12/07 30/12/07, compared to 285 Million on 12/12/05.

[52] This despite the relative technical superiority of the US standard; on 21/6/05, CDMA2000 EVDO has been in commercial use for almost two years, providing a 2.4 Megabits/s downlink data rate, while the UMTS-R5 HSDPA expected to begin with a downlink of 2 Megabits/s and was in demonstrations and field tests only.

even in the US operators transfer the US TDMA TIA-136 and even CDMA standards to GSM 850 and UMTS (and not to CDMA2000). The key reasons for the success of GSM (and its follower UMTS/3GSM) are the open and standardised interfaces (relative to the American CDMA proprietary system), appropriate ETSI standardisation, RF spectrum harmonisation and integration, interoperability, ubiquitous international roaming, open and standardised, top-down technology, economies of scale and the same units being supplied by many manufacturers. Moreover, GSM gained much of its popularity due to good timing; it was the first digital cellular on the market in Europe. GSM was developed from the first moment for export, interoperability and roaming[53]. Furthermore, Protestant countries prefer not to intervene in the cellular technology; this might be one of the reasons for the failure of the US CDMA cellular in comparison with the GSM. Central-planning Europe forced administrations to allocate RF spectrum, to adopt the GSM technology (by Council Recommendation 87/371/EEC and Council Directive 87/372/EEC), and to license GSM for 15 years. In the US, the FCC would never impose the use of any technology. The top-down GSM success may be compared to the bottom-up success of Wi-Fi. The 'no' vote on the EU institution and the imposed 'technical neutrality'[54] might threaten the EU's 'treasured policy' from the 20th century of a single technology for mobile communications. CDMA2000 might be allowed to penetrate the market in place of UMTS. Hart (2004:224) correlates the development of DVB-T to that of GSM: 'one could also argue that the Europeans had learned from their success in establishing the GSM as a global standard in the cell phone industry'.

3.2.2 Cellular standards: Analysis of the Adoption

The clear distinctions in the adoption of CDMA 1X between America and Europe is typical. Despite globalisation, roaming, global suppliers and worldwide service providers, the figures reveal the two discrete zones of influence; the origins of standards (GSM versus CDMA) continue to influence the present situation (UMTS and CDMA2000). The global success of GSM blurs its European roots; but the limited UMTS/TETRA and CDMA2000 coverage reveals their respective European and American origins. Commercially, Latin America is oriented toward both Europe and North America; it remains a mixed-cellular region, with spread deployment of both CDMA and TETRA. Japan deployed their first automatic cell phone system in December 1979; however, Japanese suppliers lost the global market by inventing a unique regulation (RF bands) and new standards (PHS and PDC) in cellular communications, directed to the internal market. Japan did not succeed in exporting its cellular standard outside East Asia[55].

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[53] Not as the PHS/PDC standards, which were developed for the Japanese NTT operator.
[54] Articles 17, 18, 30 and 31 in the *Framework* EC Parliament and Council Directive 2002/21.
[55] PHS operates also in China (known as Xiaolingtong), Taiwan and some other Asian countries.

3.3 Results- Wireless Standards

In the past, Europe deployed different wireless standards. For the last decade the European countries have become homogeneous in digital cellular technology (GSM/UMTS), digital TV system (DVB-T) and Short Range Devices (Wi-Fi, Bluetooth and RFID), due to the governance of CEPT in regulation and ETSI in standardisation. The European systems benefit from economies of scale and interoperability; they are spread across Africa, Asia, Oceania and even in the US. US-Canadian regulation and standards are implemented mainly in America. Countries around the world are drawing inspiration from Europe, and they nurture their own neighbourhood organisations (such as *Mercosur* and African Union) toward these standards. There is an advantage for wireless TV and cellular systems in providing trans-national and inter-state coverage, to enable RF coordination and interoperability. The high penetration of cellular technology is leading cellular and broadcasting operators to begin transmitting TV signals to cellular handsets.

North America and the entire American hemisphere follow the US RF allocations in general, but only North America implements the US standards. The US is a leader in innovation and new wireless technologies. American TV (NTSC, ATSC) and cellular standards (TDMA, NAMPS and CDMA2000) have not succeeded in penetrating the European hemisphere. Outside of America, they have been partially adopted in Philippines, South Korea and Taiwan. Australia, New Zealand, Jordan and Israel adopt both European and American standards. Most European wireless standards (PAL, DECT, GSM 850, TETRA and UMTS) do operate in America, including in the US (except TETRA and PAL standards). Russia and Eastern Europe have abandoned the American standards that were adopted in the 1990s (mainly CDMA850) and now prefer the European GSM/UMTS and DVB-T. However, the adoption of UMTS as the only 3G technology has been less successful, relative to the GSM.

Standards depend on the congestion of the RF spectrum and the concentration of RF usage. The European regulation fundamentally addresses the proximity of countries and the urban environment (levels of relatively high density of population), in comparison to the US. The developed countries address regulation and standards to new technologies. Some RF solutions for developed countries, therefore, may not be implemented in poorer countries. However, developed countries are good examples to follow, for those other countries wanting to gain similar networked wireless services.

3.3.1 Geography, Culture and Geopolitical Influence

The location of a country within a continent shapes its wireless standards. Figure 3-6, showing analogue and digital RF standards in 235 countries and five continents, illustrates that the European hemisphere prefers PAL, SECAM, UMTS and TETRA standards, while the US hemisphere chooses NTSC and CDMA. In general, countries using the cellular technology CDMA2000 in the 21^{st} century operated the American colour TV system NTSC in the 20^{th} century, whereas the UMTS and TETRA standards fit to the European SECAM/ PAL systems.

America is isolated from all other continents; Europe is adjacent to Asia and close to Africa; this proximity assists the flow of wireless European technologies between continents. In addition to geographical convenience in business, countries close to Europe (such as Morocco and Israel) cannot disregard the European standards, as nearby emissions may interfere with their wireless services. The vicinity of Europe to Asia and Africa was the main reason for developing one digital TV plan (RRC-06) for 119 countries; and at the same time to promote the adoption of the European DVB-T[56]. The choice of Taiwan (preferring the DVB-T to the ATSC) is typical to the adoption of European standard, in countries identified with the US influence.

The latitude factor (North versus South) exists in the place of origin and source of colonial ruler: the US and Canada were mainly influenced by UK (and France), while *CAN* countries by Spain (which like Portugal is south of UK and France). The colonial/geopolitical influence and the past (or present) imperial dominance leave footprints in the wireless standards. Countries in Africa and Asia who were influenced in the 20th century by France, UK, Spain, Portugal, and Holland in practice follow the European standards in the 21st century. The significant connection of SECAM with the French language was revealed through the statistics. The same language makes it easier for the policy-maker, regulator and standardisation institute to adopt a particular standard with other countries speaking the same language.

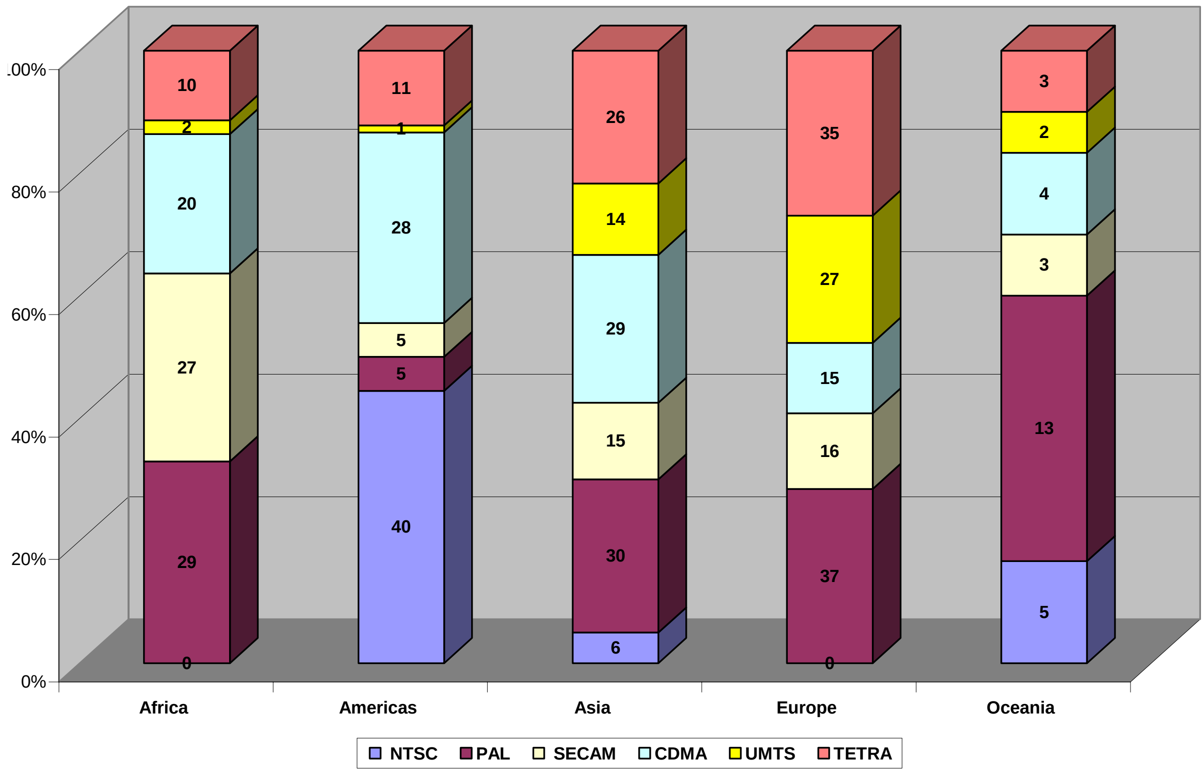

Figure 3-6 RF standards across the Continents

[56] The RRC process revived the formulation of a digital broadcasting policy in the African and Asian developing world; e.g. South Africa advanced the planning of DVB-T and the formulation of digital broadcasting policy.

4 Dependent Variables: Regulating Uncertain Risks and Innovation

The regulation and licensing of wireless services and systems is often related to risks. In addition to the uncertain risks and benefits associated with the adoption of a specific standard, there are a few aspects of RF linked directly to safety: altitude of the antenna masts (danger to low altitude flights), RF interference to airborne communications and to Fly-By-Wire aircraft (this is one reason why cellular devices and computers must be switched off during take-off and landing). Regulating the exposure levels of RF *human hazards*, the RF levels of *spurious emissions* and the introduction of innovative RF regulations are the topics explored in order to analyse the licensing of RF in uncertainty, and the influence of geography and culture on this.

4.1 RF Thresholds: Human Hazards and Spurious Emissions

Due to the vast cellular penetration and the expansion to third generation (3G), the prolific cellular phone masts are becoming a prominent issue in a way that was unheard of a few years ago. The main aspect of RF safety which affects regulation is the strict ruling regarding protection from RF radiation: the thresholds of cellular base stations (field strength and power density) and power lines (power lines are not wireless; however, the hazard is wireless, namely magnetic fields). The different reference levels of exposure and protection for the general public against Electromagnetic Fields and Magnetic Fields (hereafter EMF for both) indicate the national tolerability to risk. ICNIRP (International Commission on Non-Ionizing Radiation Protection) also defines these "polluting" fields as EMF, and refers to both in ICNIRP 1998:Table 7. Some countries acquired high profiles (low RF thresholds) which led to severe restrictions on EMF, that are at odds with those of the international community. The permitted level of *spurious emissions* is another indicator of the national risk tolerability.

4.1.1 Official National Levels- EMF, Health Risks from Cellular Masts

In order to create an inherent ordering for a comparative study, the power density thresholds for the general public (uncontrolled, adults and children) in the cellular band (UHF; 1,000 MHz reference RF) are compared. The data is gleaned mainly from the data of administrations appearing on the WHO (World Health Organisation) website[57]. Only developed countries update the WHO with their thresholds; the author added data from South American countries. Most countries follow the ICNIRP 1998 standard, which also represents the WHO position. Precautionary guidelines are mandatory only in Israel, Italy, Slovenia and Switzerland. Based on the WHO/ ICNIRP data and additional information, Table 4-1 specifies the *human hazards* power density around the world, relative to the ICNIRP level $5W/m^2$ at 1GHz; see column 5 in ICNIRP 1998, Table 7.

[57] http://www.who.int/docstore/peh-emf/EMFStandards/who-0102/Worldmap5.htm 30/12//07.

Table 4-1 RF *human hazards* comparison of national derived levels[58]

	country	power density	relative power Density	Remarks
		W/m^2	Relative to ICNIRP level	
1	Argentina	f/200	1	
2	Australia	f/200	1	
3	Austria	n/a	1	limits close to ICNIRP
4	Belgium	f/800	0.25	
5	Brazil	f/200	1	
6	Bulgaria	n/a	0.12	
7	Canada	f/150	1.33	
8	China	0.4	0.08	
9	Croatia	f/200	1	
10	Czech Rep.	f/200	1	
11	Denmark	f/200	1	
11	Ecuador	f/200	1	*Resolucion* 01-01 CONATEL-2005
12	Estonia	n/a	x	
13	Finland	n/a	1	
14	France	f/200	1	
15	Germany	f/200	1	
16	Greece	n/a	0.8	
17	Hungary	n/a	x	Hungarian Law: MSZ 16260-86
18	Ireland	f/200	1	
19	Israel	f/2000	0.1*	10% or 30% ICNIRP levels depending on the occupancy
20	Italy	n/a	0.01 - 0.2*	'Attention values and Quality goals 0.02 ICNIRP'
21	Japan	f/150	1.33	
22	Latvia	n/a	x	Latvian Law: LVS ENV 50166 – 2: 1995
23	Lithuania	n/a	x	Lithuanian Law: HN 81:1998
24	Luxembourg	n/a	0.05	'at mobile phone the limits for public exposure are 20 times stricter'
25	Malta	f/200	1	
26	Netherlands	f/200	1	
27	New Zealand	f/200	1	
28	Norway	n/a	1	Daily work based on the ICNIRP standard
29	Peru	f/200	1	
30	Philippines	f/200	1	
31	Poland	0.1	0.02	
32	Portugal	f/200	1	
33	Romania	n/a	x	
34	Russia	0.10(0.25^h)	0.2	'0.2 of ICNIRP value'
35	Singapore	f/200	1	
36	Slovak Rep.	f/200	1	
37	Slovenia	n/a	0.1-1*	
38	South Africa	f/200	1	

[58] http://www.who.int/docstore/peh-emf/EMFStandards/who-0102/Worldmap5.htm 7/10/05 and http://www.nema.org/stds/international/upload/EMF_Project_05-25-05.xls 7/10/05.

	country	power density	relative power Density	Remarks
39	South Korea	f/200	1	
40	Spain	f/200	1	
41	Sweden	f/200	1	
42	Switzerland	f/20000	0.01*	
43	Taiwan	f/200	1	
44	Turkey	f/200	1	
45	UK	41 f^2	8.2	41 W/m^2 versus $5W/m^2$ of ICNIRP; see *case study*
46	United States	f/150	1.33	

Switzerland and Italy apply up to 0.01 ICNIRP reference level for cellular phone base stations, acting against proven adverse health effects. Additionally, Switzerland also implements precautionary emission limitations (the most stringent in the world), so-called Installation Limit Values (ILV), at places of sensitive use, such as apartment buildings, schools, hospitals, permanent workplaces and children's playgrounds. Poland reduces the level by 50 times for public exposure, Luxembourg by 20 times and China is 12.5 times stricter. The compliance with environmental guidelines in Israel stands at 10% (indoors) or 30% (outdoors) of ICNIRP levels.

4.1.2 Official Levels- Magnetic Fields, Health Risks from Powerlines

The WHO source[59] also details the national magnetic fields thresholds. Relative to the ICNIRP threshold, again Switzerland, Israel, Russia, Italy, Poland and Greece are the countries least tolerant of magnetic fields, and also of radiation from power lines, electricity pylons, generators and transformers. The following countries have indicated that they follow ICNIRP levels: Austria, Czechoslovakia, France, Finland, Germany, Holland, Ireland, Netherlands, New Zealand, Singapore, Taiwan and UK. Table 4-2 indicates only the countries that apply different limits relative to the ICNIRP level[60].

Table 4-2 Countries less tolerant of magnetic risk, with more stringent magnetic thresholds

Country	Magnetic Flux Density relative to ICNIRP
Switzerland	0.01
Italy[61]	0.03 (daily mean, for more than 4 hours); 0.1 (for designed lines)
Slovenia	0.1 (for new installations)
Israel	0.1 (proposed in occupational)
Russia	0.1 (Indoor); 0.5 (Outdoor)
Poland	0.75
Greece	0.8

[59] See http://www.who.int/docstore/peh-emf/EMFStandards/who-0102/Worldmap5.htm 30/12//07

[60] 5,000/f µT; f: 50 Hz for Europe and 60 Hz for America; see column 4 in ICNIRP 1998 Table 7, RF introductory section and UK *case study*.

[61] See the 8/7/2003 Italian Presidential Decreehttp://www.who.int/docstore/peh-emf/EMFStandards/who-1/1/08.

4.1.3 *Human Hazards* Comparative Results

There is a similar tolerability pattern for regulating uncertain risks from electromagnetic fields (cellular and broadcasting emissions) and from power lines[62]. The US, Canada, Japan are the most tolerant, while Italy and Switzerland are the most stringent in this ruling. The link between the exposure levels from powerlines and cell sites is direct, despite the different character of the purported dangers. The most significant precedent for reactions against cellphone emissions was provided by suspicions about electricity pylons; similar ecological pressure groups are campaigning against both types of pollution. The opposition to the erection of both “threats” are developed on a largely economic and classically environmental basis. Demands for relocation of these “polluters” are based on health fears, as much as on concern about their impact on the devaluation of property prices, open fields, beauty of the landscape (impact on visual amenity) and even democracy's factor- their construction without consultation (Burgess 2006:339). It is necessary to explain the very different reactions and responses to these two EMF issues in different countries.

Europe in general follows ICNIRP thresholds, the non-mandatory EU Council Recommendation EC 1999/519 and the Base Station general public harmonised standard EN50385. There is a difference in the threshold levels among European countries; such a distinction however does not exist in RF standards. Northern Europe is more tolerant than the south, whereas there are no clear distinctions between western and Eastern European countries. Canada, Japan and USA follow the FCC/ANSI (American National Standards Institute) threshold (1.33 ICNIRP level). So North Americans and Japanese lead the tolerability in regulating uncertain risks in RF *human hazards*.

The low levels of *human hazards* in Russia, as explained by some researchers, are related to the bonuses offered in the past to workers in electromagnetic environments that were found to be higher than the thresholds[63]. Italy and Switzerland have found themselves isolated in the EU as a consequence of their unusual position. Italy has the highest number of broadcast towers in the world, estimated at around 60,000 (Burgess 2004:202); many are illegal broadcasting AM and FM stations. The proliferation of stations could be the cause of the public's reaction to these emissions; moreover, very high cellular penetration (123.1%, see *master data*- Appendix B) necessitates many cellular base stations. The national Occupational Safety and Prevention (ISPESL) institute, the left-wing coalition win in 1996, the Green Party's control of the Ministry of Environment and the activist Environmental Minister Willer Bordon (Burgess 2004:199) all determined Italy’s distinctive position. Italy was symptomatic of a relatively weak and fractured state, where the judiciary has amassed influence at the expense of centralised control. The low levels in Switzerland are set as economically feasible, rather than scientifically necessary. The Swiss' most stringent levels are

[62] For instance, in Israel the same law (dealing with ‘non-ionising radiation’) regulates the two uncertain risks.
[63] Informal interview of Dr. Alex Vilensky, on 11 July 05.

straightforwardly derived from official environmental ideology, and might be a political response to the considerable public pressure rather than a professional reappraisal of the issue (Burgess 2004:162,197). This could be related to what is thought to be the 'unadventurous' character of Switzerland and its mutual influence on Italy (the Italian language is also an official language in Switzerland). In the mountainous Italy and Switzerland, there is a need for more cellular towers, and due to geography and placing, the masts are more visible (Burgess 2004:50). Another country bordering Italy, Slovenia, argues for an additional safety factor of ten for new mobile installations (Burgess 2004:197). Italy and its two neighbours are the only countries where precautionary/environmental guidelines are mandatory[64]; they create a bloc of ultra-precautionary anti-EMF states, spread also by the Italian language (but not to Slovenia). It is however partly because of language that the Italian reactions have not become more widely influential, in comparison with the EMF concerns of US, Australia, Ireland and UK that were undoubtedly assisted by a shared language, among other factors (Burgess 2004:203). Canada, UK and USA are most tolerable to risk; none of the English-speaking countries applies *human hazards*' thresholds more restrictive than the ICNIRP limit. The attitude of Scandinavian countries (those favouring cellular, 'the continent of the cell phone'; Burgess 2004:32) to EMF is not surprising: the national media is less receptive to this, the issue has not become prominent in these societies and the threshold levels are maintained at the ICNIRP level.

In contrast to the thresholds of power density from cellular base stations, it is important to observe that on 31 December 2007 the US is found to be more risk averse than Europe in the allowed Specific Absorption Rate (SAR) from the cellular terminal. The ICNIRP threshold (adopted by EU) is 2.0 watts/kilogram (W/kg) EC 1999/519: Table 1, while the US limits are still 1.6 watts/kg (W/kg) (FCC 1 October 06 CFR47 § 2.1093, and WHO site 30/12/07). The main societal difference between the emission from the cellular terminal (SAR) and base-station is that the cellular utilisation is voluntary (it is our choice to use cellular phone) and the base station emission is involuntary[65]. The SAR attribute is important in demonstrating that the US is not less stringent than Europe in all RF cases. However, following changes in IEEE 2006 Standard C95.1-2005, the US ANSI and FCC may adopt in the future the less stringent ICNIRP level for SAR, and the ICNIRP 1998 values (more stringent than the US limits) for exposure from cellular base stations. Important to note that mobile phone users tend to be exposed to much higher levels of radiation from their handsets than from masts, because they are so much closer to the RF source; nevertheless, that has not stopped 94.29% (end 2006) of Europeans inhabitants from purchasing mobile phones.

[64] Pr. Dina Simunic, Archives of Industrial Hygiene and Toxicology 5 Oct. 05.

[65] The public is willing to accept voluntary risks (e.g. skiing, handset emissions) about 1,000 times greater than involuntary risk (natural disasters, base stations RF exposure) that provide the same benefit - Starr's useful law.

4.1.4 Results- RF Health Risks as a Social Story

The EMF controversy is a social story more than a strictly scientific one, as safety is a concept that is more social than scientific. Evidence is propelled by feelings and beliefs derived from worldview, values, moral principles and knowledge; rather than newly found biological processes. The reaction of people is selective and inconsistent; we live in a society shaped by consumer health anxieties. Psychology may explain why some people react negatively toward specific technologies; the invisible EMF can be compared to a childish fear of the dark and the unknown, 'a phantom risk'. It is sometimes quite an irrational attitude (and phobia) shown toward a number of possible hazards. High expectations surrounding a new technology are associated with risk, the benign suddenly turns menacing and the perception of dangers is contextual.

RF Radiation thresholds that were established individually in each country are an example of the cultural differences that exist. The management of RF *human hazards* is a problem of reconciling the roles of science (represented by the ‘truth’, by the 'weight of evidence' and by the ICNIRP threshold levels) and risk assessment (the adopted values of each country). Science is the most powerful and effective agent to provide a universal base for systematic knowledge; however, by definition science cannot prove the VOID group: the inexistence of a certain factor (of harm, in this case). The national thresholds are related to governmental and policy orientations. The adopted thresholds reveal the public trust (the Commentary of Slater in Lofstedt and Vogel 2001:410) and level of confidence in their states and institutions, and in their ability to resolve problems (Burgess 2003:15 and 2004:14). The Commentary of Renn in Lofstedt and Vogel (2001:407) links the policy styles to the four prototypes of the Cultural Theory.

Developed countries are at the highly precautionary end of the spectrum; developing countries are less concerned about health hazards. Lack of awareness in poorer countries is understandable: priority is given to other more pressing issues. Also, hypothetical risk versus profit is always a different calculation for a poor government than a wealthy one. So, in paraphrasing Tolstoy's Anna Karenina, contrary to the similarity of the regulatory wireless frameworks in developed countries: all poor countries are alike (no special rules for EMF); each developed country regulates *human hazards* in its own way (with different limits and restrictions).

4.1.5 Spurious Emissions

A significant difference among ITU Regions is the allowance of RF *spurious emissions*: the RF introductory section underlined the importance of regulating the *spurious emissions* and indicated different category limits adopted in Europe (Category B) being the most stringent, relative to USA-Canada (Category C) and Japan (Category D) regulating between the USA-Canada and European limits. In the introductory RF section, a striking discrepancy was indicated of up to 37 dB; for example, the US allows spurious levels up to 5,000 times (!) higher in power than in Europe.

4.1.6 RF thresholds - Summary

Trusting styles may lead to less precaution, while more antagonistic styles lead to lower thresholds. Moreover, trusting is linked to the presumption of innocence; less precaution is typical to the '*innocent* until proven *guilty*' way of thinking; there are no hazards to humans' or RF receivers' health until the risks are scientifically proven. In contrast, the restrictive countries presume worst-case scenarios and that RF emissions are '*guilty* until proven *not-guilty*'; RF emissions cause severe *human hazards* and interference; therefore, the RF limits of exposure levels and *spurious emissions* should be reduced. The conflicting policies are derived from different rationalities; the worldviews can be rooted in the legal origin (*common law* versus *civil law*) and religion (Protestantism versus Catholicism). Canada, Japan and the US are most tolerable to *human hazards* and *spurious emissions*; none of the English-speaking countries applies more restricted *human hazards*' limits than the ICNIRP level.

4.2 Managing for Innovation and Regulating Uncertain Risks

There are certain wireless policies, regulation, new trends and revolutionary technologies in RF regulation and licensing that overcome the rigidity of the traditional RF approach, through disclosure of innovation, progress, flexibility and a modern attitude toward risk. RF spectrum trading and Software Defined Radios have been implemented in a small number of countries around the world. The risks of innovative market-mechanisms applied too widely are a subsequent change of use, breaches of international agreements and results in increased interference[66]. However, countries not applying such a policy take inverse risks: valuable services are not launched, potential benefits are not achieved and RF spectrum is used less optimally. Only developed countries with a market-based worldview consider or adopt these new approaches.

<u>Software Defined Radios (SDR)</u>

SDR is a cognitive/ ontological radio that senses its environment and location, automatically adapting to that environment, making use of available RF spectrum and technology. The same RF band is shared and relies on coordination by using smart technology to manage interference. SDR is applicable in a “property-right” regime and in unlicensed “commons”. The adoption of SDR is an example of a new technology related to uncertain risks. SDR can change the frequency range, modulation type, or output power of a radio device without making changes to hardware components; one SDR can alter many regular radios. SDR would be able to determine their preferred communications link; in the case of cellular, it would automatically determine which standard should be used (such as UMTS or CDMA2000). Such technology may enable interoperability of various standards and the complete deregulation of RF; however, the existing RF

[66] Ofcom Spectrum Framework Review, issued 28/6/05http://www.ofcom.org.uk/consult/condocs/sfr/sfr/sfr_statement 30/12/07.

equipment is more immune to interference from SDR emissions. The US and New Zealand are pioneering the more flexible and efficient use of spectrum offered by the 'cognitive radio' concept; the US is also a driver for SDR technology in commercial applications.

Power Line Communication (PLC) or Broadband over Power Lines (BPL)

PLC, also called BPL or Power Line Telecoms (PLT), is a wireline technology that is able to use the current electricity networks, the standard 50 or 60 Hz alternating current (AC), for data and voice transmission. For example, it would provide additional access (the last mile) to the home for a broadband Internet connection, and short range home applications. The connection with the regulation of uncertain risk and *spurious emissions* is that PLC increases the RF man-made noise and potential RF interference. China, France, Germany, Singapore, South Korea, Spain, UK, and the US have been the first to deploy it; a unified EU standard is under examination.

RF Spectrum Trading

Spectrum trading is the ability of users to buy and sell spectrum licences; it is a private disposal of spectrum management rights. This secondary market brings benefits in terms of flexibility, puts the RF spectrum to its most promising uses, improves the efficient use of the RF spectrum and competition, lowers output prices and encourages micro-innovation. RF spectrum trading is related to 'regulating uncertain risks': the administration may lose control on a vital national resource and some interference may occur to Defence Forces communications. RF trading is directly related to a 'light touch' approach and liberalisation; a policy framework of favouring market mechanisms and deregulation. It is linked to property rights on spectrum: to whom does the RF spectrum belong? To that particular country or the service provider who paid for it? The answer classifies the position toward spectrum trading; for example, in France and Japan RF belongs to the state; the French government bodies ARCEP and ANFR consider trading rights for use of spectrum, and the trading of property rights on spectrum. The US, UK and New Zealand are leading the world with RF secondary trading; Canada and Australia have not applied it yet.

Innovatory RF Regulation: Results

Australia, Canada, New Zealand, UK and the US have been the first to apply RF innovation and to adopt RF auctions. These Allied countries are the forerunners; they recognise individual rights over government action. The same pattern exists in the wireless neutral technology. The common denominator of the Anglo-American Allied countries across three different ITU Regions is: language (English), religion (Protestant), legislation (*common law*), British heritage, non-tropical, developed countries, market-based and isolated from their neighbours (relative to France and Germany). Their roots are the British settlers creating a new world. The UK is part of EU, but diverges from the continent due to its excessive market-based worldview, mutual influence and the historical relations (as a result of the two world wars) with the Allied countries. The RF standards are identical, but the regulatory orientation in the UK is completely different from other Catholic and Eastern Orthodox countries in Europe; see the *case studies*. After implementing the recommendations made by Pr. Cave, it seems that the UK leads the most liberal RF regulation in the world, even more so than the US; the *case study* linked it to the economist worldview of Ofcom. Managing for Innovation is related to uncertain risks. The potential interference from SDR, PLC and Secondary Trading is disputable: those who promote the new technologies seek higher permissible power levels; whereas the operators of existing services are risk averse, fight to protect their systems and to ensure lower limits. Similarly to the thresholds of *human hazards* and *spurious emissions*, the tolerability to SDR and PLC reveals the country's attitude toward risk and its *collective values* (see *Theories*, in the next chapter).

4.3 Why Culture and Latitude may Influence the Regulation of Uncertain Risks?

From the personal experience of the author in international meetings and RF seminars conducted in 28 countries, the wireless regulators are representative of their national majority characteristics such as language, religion and tradition. The regulators are part of the main leading stream; their worldview is typical to their culture and therefore they implement the 'right' policy, the *common understanding*.

Language

The literature relates language to 'good governance', and to the various strains of capitalism in order to distinguish between market economies. "Particular cultural profiles in major world regions are less compatible with 'good governance', as defined in West European and English-speaking countries" (Licht, Goldschmidt and Schwartz 2004:32). Countries are grouped into (see PCMLP-Programme in Comparative Law and Policy 2004:79) the Liberal Market Economies (LME- generally native English-speaking OECD countries), and the Coordinated Market Economies (CME- most of Continental Europe, especially Germany and East Asia). The language reflects (and may influence) the way of thinking. For example, the word 'I' is commonly used at western-individualistic societies; English is the only language where 'I' is written with a capital I (Grosbard 2007:25). As mentioned previously, the innovative Allied Countries (Australia, Canada, New Zealand, UK and USA) speak English.

Religion

The link between religion and RF regulation is through obedience[67] and attitudes to risk and change. If Catholics show a stronger propensity to conservatism relative to Protestants, this can explain the adoption of new wireless regulation by Protestant countries. The overall philosophical concepts for RF spectrum management (such as 'light touch' regulation, simplification plans, self-certification, Software Defined Radios, technology and neutral technology) are typical of innovative

[67] Attitude to the superior; will we apply the rules and instructions strictly, or we will interpret them leniently?

entrepreneurial and frontrunner countries. These administrations treat the RF spectrum as an economic resource and apply economic tools such as RF auctions and spectrum trading to achieve greater competition and better choice for consumers. In general, Protestant countries (such as UK, US, Canada, Australia and New Zealand) are more reluctant to adopt new wireless regulation. In these developed countries, like in Japan, the church and Shinto temple are separate from the administration. Protestantism and Shinto seem to be more favourable to new regulatory ideas and innovation. The South American *case study* indicated that in Ecuador and Argentina (in Article 2 of the Constitution) the Catholic Church is not separated from the State; in Ecuador the Catholic Church is involved in State issues. Moreover, Catholicism may guide to the 'collective central-planning' approach in wireless regulation.

To emphasise the complexity in relating regulation and religion: Germany is Protestant (actually 34% Protestant and 34% Roman Catholic, with 3.7% Muslim[68]) and risk-averse in wireless regulation, similar in style to the Catholic France. Therefore, an additional explanatory attribute, the origin of legislation (*common law*) or the relative geographical isolation may explain the similarity between the UK and USA and their variance from Germany (non-isolated) and France (non-isolated and *civil law*).

Post-Colonialism and Colonial Inheritance

The rule of law and well-enforced property rights correspond with advanced regulation and have a direct effect on economic performance. The post-colonialism gives an inkling of the different regimes and regulatory frameworks implemented in a country. The Spanish, French and English inheritance also affects the legislation and the regulation of e-Communications. The Anglo-American and Napoleonic approaches result in different wireless regulation. The roles of the different administrative and judicial institutions may be crucial to the interpretation, monitoring and enforcement of regulations (the Commentary of Slater in Lofstedt and Vogel 2001:413). The British settlers in the US, Australia, New Zealand and Canada set up institutions and encouraged investment. These Allied countries now apply innovative wireless regulation and new wireless technologies. Is it the geography, origin of settlers, national spirit, language, religion, legal origin, colonial legacy or all of these factors that explain this behaviour? Perhaps AUS, CAN, NZL, UK and USA have always attracted risk-takers who left continental Europe to seek opportunity, while Europe has retained a higher proportion of people who are risk averse (Wiener and Rogers 2002:339). As one RF expert in New Zealand observed: 'The NZL culture is often noted as being very pragmatic and innovative, perhaps this is because the nation is very young and formed largely from a base of pioneers, explorers, and fortune hunters. Being young and innovative the country is

[68] http://www.exxun.com/Germany/c_pp.html 30/12/07 (page was last updated on 19 Dec. 07).

very receptive to new ideas and technologies often as a matter of necessity or survival'[69]. In addition to the societal and risk concerns, the national culture also reflects colonial memories; countries inherit from their coloniser a sense of belonging, discipline, obedience, ethics, habits, arts, music, games, food, customs, tradition and lifestyle. The interaction of the individual with the collective and the state follows these roots. Regulating uncertain risks and the policy-maker worldview are also entrenched in these origins.

The UK and French national regulation is integrated in the EU framework; their original (including telecommunication) regulation is retained in countries that were under their influence. Many administrations have preserved the UK or French[70] wireless regulation. Israel in general follows the traditional British 'Wireless Telegraphy Act' of 1949 and preserves the old UK wireless regulation, while UK and France adapt to the new EU conditions and are affected by supranational EU agreements. Nevertheless, there are UK territories such as Bermuda where the regulation follows that of the US; even the assigned telephone code is '1' as in the US (see *master-data* Appendix B).

Geographical Latitude and the Regulation of Uncertain Risks

Only those areas in the upper latitudes away from the tropics experience seasons and weather change; the change in seasons outside the Tropics forces change, at least due to the seasons. This change may affect the spirit (toward movement and freedom) and may induce less resistance to change (in regulation), protests and reforms in religion (Protestants live mainly outside the tropical zone) which would in turn initiate the interchange of ideas, entrepreneurship, innovative regulation and new wireless technologies. Some economies develop institutions that produce gradual change, long-term dynamics, growth and development, while tropical countries may develop institutions that produce stagnation (based on North 1990).

5 Summary of the Empirical Work

5.1 Main Results

The *Indicators* chapter relates the dependent RF indicators to the independent geographical and cultural variables from a global viewpoint. The sections provide sound correlations; the quantitative exercise is valuable. Whenever a country implements a wireless standard or regulates uncertain risks, there is a greater chance of linking it with its culture and geography; the results are consistent. Cultural attributes are interrelated: language, religion and legal origin. For ex-colonies, it is most likely part of the general post-colonial geopolitical influence that exhibits itself in many aspects of their life. The geography and international membership of that country in organisations shapes its regulatory framework, if regulation and standards of the international community law take

[69] Electronic correspondence with Alex Orange; 'Senior Radio Engineer Radio Spectrum Planning New Zealand Ministry of Economic Development'; 4 Aug. 03

[70] E.g. Tunisia's "Agence Nationale des Fréquences", and Algeria's "Agence Nationale des Fréquences".

precedence over the national, such as in EU (See the Commentary of Rogers in Lofstedt and Vogel 2001:414). The absolute value of latitude is positively related to wireless development. The markets of EU and USA hold the world balance of direction in wireless regulation and standardisation. There are three significant wireless global regulators: EU, USA and Japan. These 'triad powers' alone were influential during the 20th century in rules and standards. Japan, UK and US/Canada are more tolerant of risk than Europe. Canada, Japan and USA apply identical tolerance thresholds of *human hazards* and similar limits on *spurious emissions*. The three countries differ in geography, language, religion and legal origin, but they share the same risk-seeking attitude and innovative regulation. Developing countries are less aware of issues to do with regulating uncertain risks.

The 'white dominions of the British Empire' (Hills 2002:19) Australia, Canada, New Zealand, the US- and UK are developed countries, English-speaking, Protestant, practice *common law*, authorise neutral-technology licences and apply RF spectrum auctions. Some of them reform the RF regulations to include the following uncertain risks: higher power in SRD and higher thresholds of *human hazards* and *spurious emissions*. The five allied countries lead the wireless freedom in their ‘light touch’ approach.

The adoption of colour TV standard follows the colonial inheritance and geopolitical influence of UK, France and the US. Practically, for English-speaking countries, we may distinguish the UK from the US influence by the PAL or NTSC standards. The adoption of SECAM follows French colonialism, and the PAL standard indicates the European influence on Latin America. Europe is the most successful in spreading the analogue and digital standards for the TV and cellular licensed services, whereas the US is leading the development of unlicensed electronic devices (Wi-Fi, RFID and UWB) and is the first to deploy these and also Software Defined Radios. The new digital wireless systems (TV and cellular) are converged, but still retain their different origins, whether they are from Europe or USA. Europe is harmonised and integrated in RF standards. Africa, Arab and ex-USSR countries do not develop wireless systems or apply advanced RF regulation or standards; they follow CEPT and EU. The US and Canada are dominant in the American hemisphere. Asia has no leadership; the countries mix EU and US technologies. Japan is unique in its RF allocation and standards. However, Japan follows the US FCC/ANSI *human hazards* levels; in the 21st century, Japan follows Europe in the 3G UMTS cellular. China and India were inactive in the standardisation field during the 20th century; now China is developing the digital TV standard DMB-T/H, the cellular system TD-SCDMA and also tries to provide sophisticated equipment.

The penetration of cellular devices in Protestant and Catholic countries in Europe is higher than in Muslim and Christian Orthodox ones; this fact may be linked to income and western versus eastern (Russian) influence. In the 20th century the religion and legal origin were related indirectly to the colour TV adoption; in the 21st century, for most countries the specific religion and legal origin are insignificant to their choice of cellular, digital TV or any other RF standard. The language, like the religion and legal origin, echoes a colonial power that influences the present wireless standards. The SECAM TV case exposes a perceptible influence of the French language and geopolitical influence on the adopted standard. In addition to RF standards, a common language spreads similar attitudes to *human hazards* levels, as in the case of Italy and Switzerland, and the case of Australia, Ireland, UK and USA. The French cultural influence, in its ex-colonies, is deeper than that of other colonisers; France set down profound roots overseas that can be revealed in the adoption of the SECAM standard. However, the British ex-colonies, where British settlers landed, pursue an 'individual market-based' policy and implement revolutionary wireless licensing, with less limitation placed on them than the French and Spanish ex-colonies.

Based on the explanatory attributes (geography and culture) and the dependent wireless variables (TV and cellular wireless standards) in the *master-data*, the statistics draw the expected hemisphere of the EU versus US; it summarises the partition between the hemispheres. The theories in the next chapters will analyse and explain the discrepancy between the expected value and the observed value for the countries deviating from the norm.

5.2 Main Clusters of Countries

In the 21st century the convergence is mapped out into two mega-regions in the world; the convergence process is apparent in the single-market Europe; the American hemisphere is less homogeneous; there are many European standards penetrating the American market (such as PAL and DECT). Indeed, some Eastern European countries adopted the US CDMA standard (450 and 850) in the 1990s, but the American TV (analogue NTSC and digital ATSC) standards have not been adopted in Region 1 (Europe, Africa and West Asia). The Radio Regional Conference (RRC-06) exemplifies the European enforcement of the DVB-T standard to countries outside Europe in Africa, Western Asia and ex-USSR states. The diversity between EU and US in regulation and standardisation is also healthy since it can help to avoid monopolistic systems; it can prevent delays and unabated target risks, respond better to local benefits and costs, and furnish insights for continuous improvement.

Administrations are in general conservative. The decision on regulation and standards depends on boundary conditions; the present infrastructure, financing, suppliers and operators bound the alternatives. There is a normal pattern that persists in most RF indicators: Africa, ex-Soviet Union countries (RCC) and the Middle East follow the European example. EFTA countries pursue the EU R&TTE regime; Iceland, Norway, Liechtenstein, Switzerland are closely economically aligned, as well as geographically, to EU countries. The wireless rules of Latin America are oriented toward North America and Europe. Regarding wireless regulation and standards, we may roughly divide the location and geopolitical influence into these major groups:

-Europe: EU/ EFTA/ Eastern (non-EU, mainly EU candidates).

─ Africa: Arabic; *Françafrique*; English geopolitical influence.

─ Asia: Middle East; Central Asia; Pacific; Australia and New Zealand.

─ America: USA/ Canada; Latin America.

Scandinavian countries and Central Europe operate in a similar RF framework to the rest of Europe, but in a different style. Across the Atlantic, the US and Canada implement similar regulation. The western side of South America, separated from the east by the Andean mountains, is more homogenous than the eastern side: all countries operate the NTSC system, while the eastern side is less influenced by the US; many countries operate the PAL system. The wireless regulation of Latin America today follows the US rules in general; however, the orientation is different from the US/ Canadian approach; the RF allocations are similar, but the implementation is poles-apart: a Catholic *civil law* central-planning approach, versus the Protestant *common law* market-based rationality.

Let us now move from the Atlantic world, dominated by the US and EU, to that of the Pacific; though Europe and South America served as *case studies*, it is interesting to take an in-depth look at Asia, the biggest and least homogenous continent as regards wireless regulation and standards. Asia is not harmonised, as there is no single leadership; China is the big sister: elder, GDP growth rate exceeding 9%, wider in population and area; together with India (8% growth rate), the origin of Buddhism (the root of Shinto); but Japan is still the largest industrial power, operating in a unique wireless standard environment. As opposed to ITU allotment plans for Europe (ST61, GE84), Africa (GE89) and America (RJ81), there is no an exclusive Asian plan for Broadcasting (ITU GE-1975 plan for Medium Waves is for Europe, Africa and Asia). There have been efforts to standardise software and communications in the CJK[71] region of China, Japan and South Korea. The Asian countries are divided by American influence (Micronesia, Philippines, South Korea and Taiwan) and that of Europe (Arab countries, China and India). For the time being there is a multi-state leadership. APT is not influential in Asia, as CEPT is in Europe; for the moment, EU standards are more familiar to many APT countries.

6 Conclusion: Indicators

The *Indicators* chapter uses the dependent wireless variables of cellular subscribers per 100 inhabitants, cellular and TV (analogue and digital) standards, RF *human hazards*, permitted *spurious emissions* and innovative regulation in order to identify worldwide clusters of regulation styles, societal and risk concerns. After the partition of USSR (1992), the global balance between the two superpowers (USA and USSR) was shattered. This chapter indicates a new balance between

[71] The collective term for Chinese, Japanese, and Korean, the main East Asian languages.

the RF rules of the EU and the US. There are two distinct hemispheres identified in the regulatory frameworks of wireless communications, societal concerns and risk. Most wireless rules and standards originate in either Europe or US. The wireless regulatory framework and adoption of standards are applied at both regional and national levels. This chapter provides a wider perspective to the *case studies* in the preceding chapters. Countries tend to be stable, to operate wireless systems in an evolutionary (not revolutionary) manner, within their geopolitical hemi-sphere. Fundamentally, in the 21st century the EU and the US are most influential in RF allocations, licensing and wireless standards. In addition to US and Europe, Japan, China and South Korea are important suppliers of wireless equipment. The wireless development is attributed to geography and culture. This chapter reveals the influence of geographical longitude and latitude, language, religion and legal origin on RF standards and regulation. The difference in wireless evolution between tropical and non-tropical countries may be related also to 'change' (seasonal change). Culture (of slightly less importance than geography) further shapes the differences in wireless regulation and illustrates the clusters of countries implementing similar wireless standards.

Europe is harmonised in regulation and standards. This is a result of prudent long-range planning; GSM is the prime example of this. There is a regulatory consensus within the US and Canada; Mexico also follows other NAFTA countries (operating NTSC, ATSC and CDMA). There is no globalisation in the digital TV or cellular 3G/ 4G standards; global convergence exists only in the SRD; the bottom-up Wi-Fi is a perfect example of this[72]. The analogue colour TV systems (NTSC, PAL or SECAM) and cellular standards (UMTS versus CDMA2000) operated in different countries are referred to throughout this chapter, since these anchors designate the framework of the wireless regulation, and suggest a tendency for RF regulation and standardisation. The sources of the colour TV standard (NTSC- USA, SECAM- France and PAL- UK and Germany) and cellular systems, UMTS (Europe) and CDMA (USA) serve to correlate geopolitical influence and wireless technology. The practical role of the state is essential in regulating the licensed services (such as TV broadcasting and cellular), while the standards of the unlicensed Short Range and Electronic Devices of new wireless technologies (such as Wi-Fi and Bluetooth) are shaped by the global market.

As statistics cannot separate them, the causes and effects may interchange; however, the wireless regulatory framework is an effect of culture, not a cause of it: 'the direction of causality is from culture to governance' (Licht *et al.* 2004:30). This chapter characterises this correlation. An analysis of the RF regulation reveals the roots and the basic characteristics of how national characteristics guide regulation. Looking at the empirical results, RF regulation and standards follow the post-

[72] About 75 million devices were shipped in 2004, about 160 million in 2005, 213 million in 2006 and 300 million in 2007; Wi-Fi Alliance® and In-Stat http://www.wi-fi.org/pressroom_overview.php?newsid=643 4/1/08.

colonial and geopolitical influence. The specific RF items also disclose the regulator's worldviews and rationalities: the social central-planning French-Catholic approach, versus the Anglo-American Protestant market-based orientation.

'Much of the prized spectrum is idle at any given instant and location'[73], therefore countries may take more risks in regulating the RF power levels and *spurious emissions*. The diverse regulation of wireless risk and adoption of new RF rules reveal the different precautions taken by EU and US. The attitudes toward business (versus risk-perception) are more favourable in Australia, Canada, Japan, New Zealand, UK and USA, compared with continental Europe; these innovative countries remain averse to industry's regulation. It may explain why they are more tolerant in regulating uncertain risks and managing RF for innovation. The common attribute differing them from tropical countries is the *change* in seasons and religion (Shinto and PROTESTantism)[74].

This chapter provides empirical data; the evidence is shown through statistics. The chapter identifies the national characters to explore the reasons behind wireless development (and underdevelopment). Historical circumstances and purely political processes concur in regulation and standardisation; however, the statistics consist of large number of countries (in fact all countries!), and reveal the contribution of each cultural factor. Geography and culture trace the concrete aspects of wireless regulation. The influences are interdependent, as the explanatory factors themselves are related: location, geopolitical influence, language, religion and legal origin. The cultural variation can be seen among countries through their regulation and standards.

It seems that the preference for a regulatory rationality has persisted in the past because of inertia and not as an efficient social choice. There are different styles of regulation; the cultural characteristics of policy-making bind regulation; the rational solution is bounded by geopolitical influence. Statistics reveal anomalous rules by indicating the deviation from the present standards and the expected rational value. The theories will explain the results to provide the meanings and the mechanisms that link them. This chapter quantified how geography and culture guide the adoption of wireless standards and the tolerability to risk. The following chapters cover the theoretical analysis in order to understand and explain the empirical results.

Three tables detail the empirical data:

Table 6-1 *Master-Data*: 235 Countries; Geography, Culture and RF factors; see Appendix B[75]

Table 6-2 specifies the sources of the *master-data*; Table 6-3 the abbreviations and comments.

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[73] Based on measurements at Carnegie Mellon University and elsewhere in the US; IEEE Communications magazine, Feb. 05; Peha J.M.. If it is true for the US, it is true for most of the world; the author.

[74] And the waving Ocean being part of their culture.

[75] The excel file includes some notes e.g. Barbados uses the USA '1' assigned telephone; these remarks are available only in the magnetic excel file.

Table 6-2 The sources of the *master- data*

Variable	Source of Information
Country	http://www.statoids.com/wab.html 4/1/08 ; http://www.itu.int/ITU-R/terrestrial/glad/index.html 4/1/08
ITU code	http://www.itu.int/ITU-R/terrestrial/glad/index.html 4/1/08, and ITU-D List sent to the author on 16 November 2007
Country Codes	http://www.statoids.com/wab.html 4/1/08
ITU-R Region	ITU-D file sent to the Author on April 05
Sovereign State	ITU-D file sent to the Author on 16 November 07 ; see also country code comments
Phone Code	ITU-T Recommendation E.164 Assigned Country Codes (position on 1 May 2005) http://www.itu.int/itudoc/itu-t/ob-lists/icc/e164_763.pdf 4/1/08
Official Lang	http://www.ethnologue.com/country_index.asp 4/1/08 and http://exxun.com/enpp/fd_languages_1 4/1/08
Primary Religion	http://www.exxun.com/afd/pp_religions/fd_1.html 04/1/08
Latitude	EXXUN http://exxun.com/enmp/fd_geographic_coo_1.html 4/1/ 08
Tropic	Calculated from the Latitude
Regional Membership	http://www.fratel.org 4/1/08, http://www.citel.oas.org/states.asp 4/1/08 http://www.aptsec.org/member/members.html#member 4/1/08; http://www.atu-uat.org/members.htm 20/4/05; http://www.iirsa.org/Paises_ENG.asp?CodIdioma=ENG 22/4/05
Law; Legal Origin	http://rru.worldbank.org/Documents/DoingBusiness/2004/db2004-indicators.pdf 4/1/08; 'Lex Mundi project' (see La Porta *et al.* 1999 and Djankov *et al.* 2003) http://www.cia.gov/cia/publications/factbook/index.html 4/1/08 sovereignty (e.g. French Guiana colony of France)
Left/Right Road	http://www.brianlucas.ca/roadside/#listofcountries 4/1/08
Frequency 50/60	http://users.pandora.be/worldstandards/electricity.htm 4/1/08 and http://www.tvradioworld.com/directory/Television_Standards/page6.asp 4/1/08
Development	A document sent to the author from ITU-D from Feb 04 and http://www.ea-ohp.org/downloads/developing_countries_list.doc 4/1/08
Mobiles %	Lists sent from ITU-D to the author on 13 November 2007 and http://www.itu.int/ITU-D/ICTEYE/Indicators/Indicators.aspx# 4/1/08
TV Analogue Colour	ITU-R 2004, report BT. 2043; ITU-R 2005 BT.1701; resolution RRC04: Annex 3.1; BT.470-6; CCIR report 624-3; EBU TI I-33-1996; http://www.vidpro.org/standards.htm & http://www.tvradioworld.com/directory/Television_Standards/page6.asp 4/1/08 and 'UNESCO Pacific Islands Television Survey '; Crane (1979: p. xvii) list of colour TV
Digital Video	ITU RRC04 Annex 3.1: Digital Broadcasting in the VHF & UHF bands
GSM	http://www.gsmworld.com/roaming/gsminfo/index.shtml 4/1/08 and http://www.gsmworld.com/news/statistics/netsonair.pdf 25/9/07 and 4/1/08

CDMA	http://www.cdg.org/worldwide/index.asp 4/1/08
UMTS	3G/WCDMA www.gsacom.com 4/1/08
TETRA	http://www.tetramou.com/tetramou.aspx?&id=2413 4/1/08

Table 6-3 Abbreviations and comments of the *master-data*

Abbreviation	x: not available data; 1_1: Unique; 1_2: in only one or 2 countries or Indigenous; Dev (Development) 1: Developed; 2: Developing; 3: Least Developed Country
Language	ARB Arabic, CHN-Chinese, DEU- German, ENG-English, FRA- French, ITA- Italian, NLD- Dutch, SPA-Spanish; POR- Portuguese
Religion	BDH- Buddhist; CTH- Catholic; EST-Eastern Christians; HND- Hindu; MSL- Muslim; PRT- Protestant
Legal Origin	DEU: German, ENG: *Common Law*, FRA: *Civil Law*; MS: Muslim, NRD: Nordic RUS: Socialist
Geopolitical	(in addition to language) AUS- Australia, DNK- Denmark, EEC-East European, HOL- Holland, NZL- New Zealand, and USA. OCN: Countries dominated by AUS or NZL

Chapter 5 *Theories*: *Three Sociological Theories*

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Preamble

This chapter presents theoretical approaches which have been developed in other arenas as a means of understanding how society functions and how decisions are made. The rationality of the decisions made is essential in explaining the diverse wireless rules and standards that exist. Radio Frequency (RF) is a rare resource; wireless communications are a networked service of general economic interest. The RF is an ethereal medium called "spectrum"; e-Communications using RF are known as wireless communications. The chapter discusses regulation, especially of RF uncertain risks (such as *human hazards* and *spurious emissions*), with reference to the allocation of any rare resource (such as land and water) to society, or of any network industry (such as transport, water, post, gas and electricity). Certain scarce resources that are not used are durable and may be conserved, like land, water and oil. Other resources are wasted if they are not used, RF being such a case. The chapter explores analytical perspectives to evaluate the *regulatory frameworks*, *societal and risk concerns*; it explains and discusses three theories and how they could apply to RF, and in which ways RF is not currently very well theorised. The research concerns the methodology and application of theories in wireless communications that are of interest to society. This chapter explains the theoretical frameworks that are adopted in the thesis; *Cultural Theory* (henceforth abbreviated as CT), *Bounded Rationality* (BR) and *Rational Field Theory* (RFT) are employed in the thesis to analyse the phenomena of allocating RF bands, issuing licenses and standardising equipment. The *Case Studies* chapters and *Indicators* chapter (thereafter *Case Studies* and *Indicators*) evaluated the clusters of nations employing a similar regulatory format. Geography and culture served as independent variables in analysing dependent variables (such as cellular technologies and TV standards) and uncertain risks (such as permitted RF *spurious emissions* and *human hazards*). The *Case Studies* and the *Indicators* showed how geography and culture influence regulation, *risk tolerability* and the adoption of standards. The empirical study indicated certain factors, *bounds* or limits that drove each examined country toward its particular regulatory framework. The sections in this and the next chapter have the ultimate effect of permitting a better understanding and explanation of the empirical results.

The three theories are used to understand:

1) *Why* do culture and geography influence RF allocation and licensing?

2) To what extent do sociological theories of risk explain the empirical results?

3) What are the different *rationalities* in RF allocation, licensing and standardisation?

Issues of human needs and wants, the social bases for cultural or institutional choices, uncertainty, imperfect knowledge, and irrationality are often ignored because they are too difficult to represent in equations and computer models. The search is not for the 'best' answer, but for two to four answers depending on the importance placed on different criteria, each of which is based on a cultural and technical assessment. The author will not raise a new theory but a new, wider, original look at a topic, based on the engineering and social sciences. Conventional theories will be used in unusual applications. CT, BR and RFT have never been used before with RF regulation and standards in identifying the roots of *societal concerns* in this area. For the first time, research is carried out to investigate their utility in the RF regulatory framework and the analysis of different rationalities. CT explains the regulation of uncertainties. BR indicates irrationalities in RF regulation, and transfers an objective irrationality to a subjective irrationality. RFT is the tool used to present the rationalities; it illuminates aspects that are usually unexplored; such as moral issues in allocating scarce resources and regulating uncertain risks. RFT will also serve as a design tool. The theories assist to focus, organise and lead ideas into a coherent academic path; taking into account the social, geopolitical and cultural considerations not previously tackled. CT, BR and RFT analyse network industries and wireless standards in different ways to provide a regulatory 'model' (Seedhouse 1997:43-4). The organisation of society reflects its culture. The thesis is aimed to understand the emergent order in human cultures, in the specific case of wireless telecommunications; the theories are the tools used to describe and interpret the *social order*; the research determines the rules that decision-makers follow, even if the decision-makers are not able to articulate these rules. The research is about national rules and standards; when the theories analyse the individual, it is in order to highlight the national and decision-makers focus: their *Culture*, *(Bounded) Rationality* and *Rational Fields*.

Theories are necessary to analyse the regulatory framework, *societal and risk concerns*. They explain why the specific rule or standard was chosen, examine the similarities and differences in specific regulation objects, and classify countries according to their regulation. In the research, the theories provide a systematic methodology for analysis and comparison of the *Case Studies*. The theories provide the generalisation and abstraction to illuminate the wireless rules and standards in a wider context; this is also an opportunity to share lessons with other networked services of general economic interest. Three different theories have been selected to evaluate the subjects from various angles, understand the different rationalities, and analyse them in an interdisciplinary research. The RF *regulatory frameworks*, standards adoption and risks set the scene as a means for further emphasising how culture and geography underline the positions of countries on this subject. The theories analyse and clarify the *societal concerns*, rationale and empirical results. The ideas and theories most relevant to the *Case Studies* and *Indicators* will assist in drawing the appropriate conclusions from the empirical results. This chapter evaluates the social context; the *social networks* analyse the decision behaviour and indicate the *collective values* of the prototypes in *Cultural Theory*, the sources of the *Bounded Rationality*, and the fields (values and instincts) of the *Rational Field Theory*. Following this the three theories are discussed.

1 The Social Context- *Social Networks: Culture and Rationality*

Social networks will indicate the determinants in formulating the different rationalities of administrations. 'A well-designed institution … is both internally consistent and externally in harmony with the rest of the *social order* in which it is set' (Hood *et al*. 1999:211). A deeper understanding of the *procedural* rationality and of the limits on human rationality requires a closer examination of how the human mind works (Simon 1981:49) and psychological attitudes. Psychology's connection with BR and *Cultural Theory* (CT) is the fact that the personal behaviour differentiates between cultures and national regulations. A *Bounded Rationality* (BR) and cultural prototypes exist in all our social frameworks, from the individual through to the national regime. This research explores the differences in societies, which causes the variation in regulation. The interrelationship of the individual being governed and the state defines the national pattern of wireless regulatory framework. The explanation for the diversity between countries' regulation could be their different decision-makers' character, ego, super-ego and super-individual; that is, their worldview, values, moral principles, knowledge, way of thinking about life, traditional ways of doing things, what it means to be human, how human beings are constituted and how life functions generally. The language, religion and legal origin of each country are predictive attributes of their worldview, and therefore can be used to explain the rationale of the regulator and national 'irrational' decisions.

The different rationalities (four CT prototypes, BR and *Rational Fields*) are formed in the *social networks*, and may reveal the BR in decision-making. National institutions, allocation of scarce resources, service networks and markets are shaped according to these *social networks*, the national *common understanding*[1] and the 'multi-dimensionality of values' (Morand and Stagl 2001:5).

Figure 1-1 is a diagram of the structure of *social networks*, connections and interactions using concentric ellipses, to depict the spheres of influence[2]. The chart illustrates the various *social institutions* connecting the individual to society, the 'rational' *social order* and social structure; it may identify and describe a rather well-defined hierarchic structure. Culture may separate the decision behaviour into four rationalities, and may cluster *Rational Fields* and form *Bounded Rationality* behaviour within every type of hierarchy: individual, nuclear family, city, state, super-national and worldwide. Culture provides the explanatory factors for each country's clusters. Language and religion carve the 'ego-ideal' (also called 'super-ego'), and explain our bounded rational behaviour in ruling, adopting standards and regulating uncertain risks.

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[1] The *common understanding* is linked to the 'principle of understanding' in the social context of open-source software; Raymond 2000 http://www.catb.org/~esr/writings/cathedral-bazaar/cathedral-bazaar/ar01s11.html 16/3/08

[2] Kasperson and Kasperson 2001 (see Introduction Figure 1-1) portray similarly the space and scale relationships in global environmental change. Figure 1-1in this chapter is original.

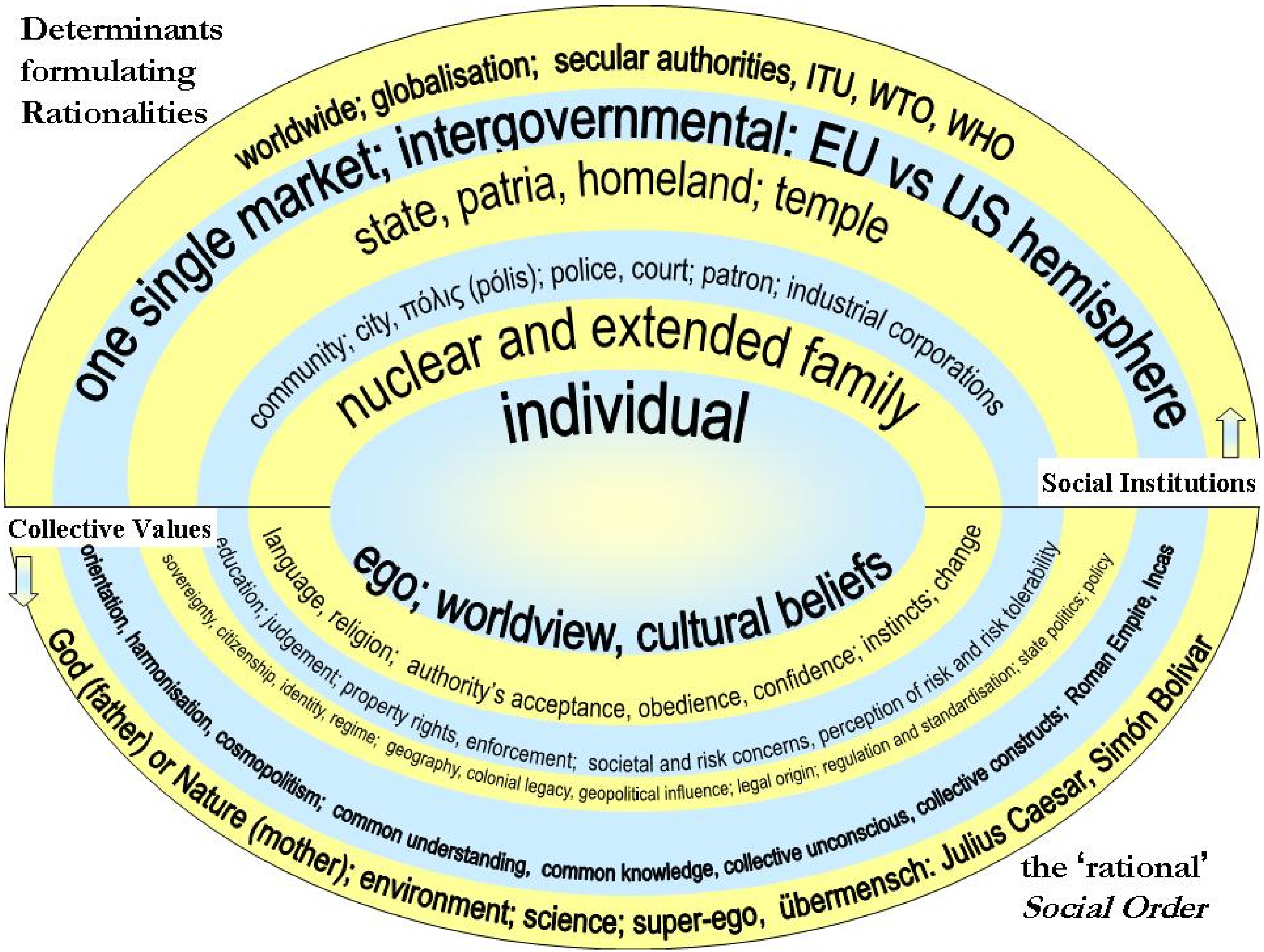

Figure 1-1 Spheres of influence: *social networks* and interactions

Figure 1-1 summarises the determinants formulating rationalities, the *social institutions* implementing BR and the *collective values* where BR is originated. The outermost circle represents our global sphere; the innermost circle is the individual, the centre of the *social networks*; at least in the western worldview. The upper section of the figure illustrates how a single person and decision-maker affects (and is influenced by) the *social institutions*; the lower section shows the cultural values and collective responsibility of the upper institutional shell, the interaction of the *collective values* and the *social institutions*. *Social institutions* and *collective values* shape the regulatory framework, *societal and risk concerns*. The *Case Studies* presented in this research served to link the wireless regulatory framework to the social institutions; the preceding chapters correlated the regulation of RF uncertain risks and the adoption of wireless standards to the *collective values*: language, religion and legal origin. The mother-tongue[3] and religion[4] are the most elementary attributes formed in the nuclear family; therefore, people may hold more confidence in partners and in institutions with a common language and religion.

The legal origin is less straightforward (and less significant); it is shaped at a 'superior' institutional level, the *home*land. The EU countries may abandon their legal system, and possibly even their religion may become less important; but will they ever abandon their national language? *Social institutions* establish rules; this research emphasises the regulation and standards founded in the national and higher levels.

Risk communication is defined as a two-sided process involving interaction between the government and the public, where there is the exchange of information concerning risk and value judgements. *Social networks* shape the personality traits of decision-makers, their 'behavioural specificity' (Barsky *et al.* 1997:550) and the rationality of the society; thus, also the regulatory framework, *societal and risk concerns*. Figure 1-1 indicates the *collective values*: including *societal and risk concerns* and *risk tolerability*; the figure describes also how risk messages can propagate (amplified or attenuated[5]) through *social institutions*. The following subsections explain the attributes specified in the figure. The attributes that convey and explain the rationalities subsist in *social networks*, starting with the individual and progressing to family, city, state and globe.

[3] The language is a vital part of our body. At least in Latin, Bulgarian, Deutch, English, French, Italian, Polish, Russian, Spanish, Russian, Hebrew לשון and Arabic لسان the same word is used for tongue and language.

[4] The religious acts of Baptism in Christianity, Circumcision in Judaism, Islam and in other cultures (such as South Koreans, Filipinos and Chinese) is practiced about eight days after birth.

[5] See also Chapter 'Literature Review' Figure 2-1 'Ripple effects amplifying the risk'.

1.1 Social Networks and the Individual

Individuals adopt attitudes toward risk in general, rather than certain attitudes toward certain kinds of risks and different attitudes toward others (the *subjectivist* approach; Douglas and Wildavsky 1982:194). "Each thinker is a prisoner inside his definable *cognitive scheme*" (Douglas and Wildavsky 1982:192); the informal and the formal institutions of a society can emerge only when individuals share the same *cognitive structure* (Mantzavinos 2001:67). *Cultural Theory*, *Bounded Rationality* and *Rational Field Theory* will explain how he/she reached this global view and how its boundaries were fixed. The rational choice of the nearly omniscient *homo œconomicus,* the decision-making of the *homo politicus,* and the boundedly rational *homo psychologicus* of cognitive psychology may explain the human behaviour and the regulator's personality traits in decision-making contexts. The individual's worldview influences his/her decisions; it ripples as social- amplification to colleagues (inter-personal), and to the upper organisational levels- the *social networks*; see the next chapter section 2.2 about the *social amplification* of risk. The personal worldview and behaviour could be derived from family (parents and extended family), place of birth (geography), values, instincts, priorities, morality, norms, psychology, personality, self-esteem, ethics, interests, working place, income, urban/ rural residence, habits, lifestyle, age and mentality. The regulatory framework of the State originates in the behaviour of the individual. His/her relations to the superior rank and authority form the loyalty, trust, obedience, attitude and nature in politics (as citizen or decision-maker). Human rationality is a *Bounded Rationality*; Herbert Simon indicates that 'radical irrationality' exists in the balance between reason and passion (Simon 1985:294, 301-2). Reason and passion craft us; reason denotes the 'rational' and passion the 'irrational'[6]. Reason is, and ought only to be the slave of the passions, and can never pretend to any other office than to serve and obey them (Hume 1740/1985:415). Passion may cause 'irrational' decisions. The individual exhibits rationality, irrationality or *Bounded Rationality*. We are different, our cultures are different: Schwarz and Thompson (1990) title it (and their book) '*Divided We Stand*'; people are different; we behave and act differently, because we really believe that it is the right way. People stay with their convictions and do not change their social visions, *risk concerns* or risk perception easily. The welfare, preferences, choice and judgment of the individual are the basics of a liberal society.

Social feelings rest on the foundation of identification with others, on the basis of an 'ego-ideal' in common with them. Freud's position is that the 'super-ego' sets up our *social order*

[6] Nietzsche 1872 *The Birth of Tragedy* defends the Dionysian principles of emotion (the irrational): the collapse of order and boundaries; it is opposite to the dispassionate rationality (the rational) of Apollo.

and the expectations from society (Freud 1935/1957:49). Carl Gustav Jung conceptualised the *collective unconscious*[7] as establishing our relations with our group and towards strangers. The *collective unconscious* may guide decision-makers to decide with whom the country wants to be identified; it provides a deeper meaning (in addition to commercial interests) to the regional participation and intergovernmental unions. The *collective unconscious, cognitive structure* and the *common understanding* may categorise the acceptance of worldwide regulation and globalisation, and may define the distrust of accepting standards from strangers or enemies.

Diener and Suh (1999:441-3) compare and contrast the individualist and collectivist approaches: national regulation and cultures differ in whether they give priority to the individual or to the group. In individualist cultures (such as the UK and the USA) the individual is afforded more freedom; in collectivist cultures (such as Ecuador) people subordinate their feelings to those of the group. The regulation indicates where nations stand on this continuum. Western culture emphasises democracy and the individual. This ideology is derived from that of ancient Greece: the person and his/her body are important, mythologised and sculpted. The *individualist* Sophist Protagoras stated: individual is the test of all truth. The roots of Christianity lie in Jesus' sacrifice of his life to save the individual[8]. Christianity places the individual rather than his/her social group in the centre of its theology (Greif 1994:923). It is opposite in Judaism and Islam: Abraham sacrifices his son[9] for God. Buddhism highlights family and lack of ego (Buddha *ca.* 450:150,422). The family, the tribe and collectiveness are central in traditional cultures. The Western attitude toward the individual explains why both the *collectivised central-planning* and *individualised market-based* approaches in Western administrations are similar; they seek to better serve the 'citizen-consumer' and business users.

Moral values and aesthetic tendencies are founded in the ego (Freud 1935/1957:47). The typical relations within the family (completely different in Western versus traditional cultures) define a representative pattern of a society; this prototype classifies human interactions and even the regulatory framework: whether *individualised* or *collectivised.* Between the individual and the State exist several hierarchies, evolutionary processes and a *rational order* (Smith 2002:508): individual [Ego, Super-Ego (Freud 1935:706), super-individual (Smith 2002:517), *ubermensch* (Friedrich Nietzsche 1872) and *collective unconscious* (Carl Jung 1947)], nuclear and extended family, tribe, village, locality, state,

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7 Jung C.G. 1947 *The Archetypes and The Collective Unconscious* Princeton, NJ: Princeton University Press.

8 It is the essence of the *Sacramento*: *Corpus Christi* is the bread; his blood is the wine.

9 Isaac in the Old Testament, or Ishmael in the Korean.

super-national, regional and world. The regulation, *societal and risk concerns*, perception of uncertain risks and adoption of standards relate to each *social institution*.

1.2 *Social Networks* and the Family

The individual is biased toward home-grown principles of action, norms, traditions and morality. Almost all societies have elementary units called families, which may be grouped into villages or tribes, and these into larger groupings, and so on (Simon 1981:186). Children mimic the language and the actions of their parents. Buddha taught that ‘a family is a place where minds come in contact with one another’ (Buddha *ca.* 450 BC/1966:432). Confucius believed universal harmony was represented in the code of ethics within family relationships: the family is 'a balance of ancestral worship and respect for **authority**'; family 'insures political stabilisation'[10]. Those religious and philosophical views may justify the role of the ruler, and elucidate the collectivism of the East versus the individualism of the West; this variety is reflected also in the different policies in wireless regulation. The individual is socially-grown and acquires the rules of action in the family at home, generation-to-generation. The perception of certain dangers and the highlights of other risks are related to institutional life, religion and family. Religion may characterize the attitudes toward time[11]: how to look to the past and future, short term and long term, change, life and immortality. The nuclear family also contributes to the *risk concerns* of the individual; ‘the public perception of risk and its acceptable levels are *collective constructs*, a bit like *language* and a bit like aesthetic judgement’ (Douglas and Wildavsky 1982:186). These attitudes may explain the diversity in regulating uncertain risks. The trust and confidence in a divine authority filters anxieties about perceived apocalyptic dangers, such as environmental and electromagnetic risks. Humans perceive the world through perceptual lenses, filtered by social and cultural meanings, transmitted via primary influences such as family, ethnic groups, friends, super-ordinates and fellow workers[12]. The relation of the individual to his/her elders and caretakers represents all moral restrictions. In many cultures the home (e.g. Judaism), the motherland[13] and the earth are identified with the mother. The word 'dominion' (colony) is a derivative of Latin *domus*- house (and *dominus*- lord). Parenting styles influence the policy and governmental styles for regulation. The mother, father and the extended nuclear family establish the social 'norms': what is 'natural', good, right and

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[10] Confucianism taught: http://www.etext.org/Religious.Texts/Gaia/gaia2.doc p. 12; 4/1/08.

[11] Douglas and Wildavsky 1982:86-7 emphasise the diversity of attitudes toward time, and the balance of social past and social future; the essay does not relate 'the attitudes toward time' to religion; the author tries.

[12] Ortwin Renn 'Concepts of Risk: A Classification', in Krimsky and Golding 1992:67.

[13] Note the term ‘Motherland’ (*Mutterland* in German) for Homeland, to parallel Mother and Home.

desirable in a society. The family forms a person's cultural roots: language[14], religion, tradition, inheritance, behavioural norms, discipline, obedience, sense of belonging, geopolitical influence, personal values, ethics, habits, attitude toward one's superiors and toward gender, arts[15], music[16], games, food (e.g. 'Halal', 'Kosher'), lifestyle, heredity, biological evolution (Smith 2002:529), genetics (Diener and Suh 1999:448)[17], interpersonal trust (Diener and Suh 1999:443) and health. A boy/girl struggles to identify with his/her father (Freud 1935:35,39,40); as the authority figure carries the office of the father, the conflict defines the relationship between individual and administration. When we grow into adulthood; various other individuals or organizations take the place of the father and his prohibitions: discipline, religious teaching, schooling, reading (Freud 1935:45). The race and the parents are the foundations of the individual and influence him (Freud 1935:46); culture is carved by parents as in granite, and is difficult to change.

Culture and the determinants of rationalities may explain different regimes and the regulatory patterns in different races; therefore, cultural aspects can be responsible for the main differences in regulation. In traditional cultures and in the East, the extended family is powerful; the person is not a free atom, but a part of a collective. In western culture the individual is the centre of the world; an example of cultural value that prevails in Western societies but not in others. Cultures that socially are family-oriented may prefer a collectivised rationality: social solidarity, one organically-grown organisation and command-control style. The culture (mainly legal origin and religion) also classifies the attitude toward individual property: according to John Locke 'it is the chief end to putting persons under government' (Locke 1690/1988:350; see also Adams and Thomson 2002:26). Protestantism may promote capitalism (Weber 1904-5/1947) and individualism; in Buddhism 'every article entrusted to us…is not 'ours' but is only entrusted to us temporarily'; in building Buddha's land, the fourth guideline is the 'equal sharing of common property' (Buddha *ca.* 450 BC/1966:440,484). Confucius taught that 'social relations could be harmonised by propriety'[18]; the Japanese Shinto is less collective and more capitalised. In the Confucian and Shinto views, *social order* rests on righteousness in relationships of superiority and subordination. The farmers were used to the collective style of farm work. The respect for one's elders, the devotion to **parents and family** (*Ko)* are translated to the esteem for one's manager, patron and regulator. The obedience, loyalty,

[14] See separate subsections for language (1.2.1) and religion (1.2.2).

[15] The dynamism (change) in Western art, e.g. painting and sculpture, compared to the stillness of Eastern art.

[16] Confucius: Music and dance are enormously important to keep society in good order http://chinesefinearts.org/4/1/08.

[17] Moreover "A human being can only do what his genes program him to do" cited in Simon (1982:361).

[18] Confucius (551-479 BC) http://www.san.beck.org/EC27-Summary.html 4/1/08.

motivation and paternalism of the leaders, *Samurai*, are preserved in the social unity and the relationship between employer and worker. *Chun* is the unquestioning loyalty (of the *Samurai*) to one's lord and *Shu,* which means faithfulness to the nation, community or organization to which one belongs.

1.2.1 *Social Networks*, the Family and the Language

Language is the ultimate cultural artefact. A 'common language' leads to low 'relational distance' (see Hood *et al*. 1999:214). The use of language is the most characteristic cognitive skill of human beings; language is significant in excluding the *barbarous*[19] the 'other'; however it is also *sui generis*[20]*,* representing tradition and history. 'We learn the rules of a language and of efficient social intercourse, without explicit instruction, simply by exposure to *family* and extended family *social networks*' (See Pinker 1994, cited in Vernon Smith 2002:508; emphasis added). The 'language' (like the brain's vision and socialisation circuitry) emerges as one of the most natural factors of every culture. The language reveals the geographical, cultural, colonial and geopolitical influences[21], being itself the consequence (the lasting impact, and sometimes the foundation) of religion, tradition and the vital relation to the mother. A large body of literature holds that language affects people's social inferences and value judgments; language may function as a repository of aspects of the *common knowledge* in society (Licht *et al.* 2004:28). Language is the first attribute in building confidence[22] and loyalty. To clarify the importance of the mother tongue: in the frame of a Common Europe, with no actual borders, a single harmonised market, (almost) one currency, with the same dominant religion of Christianity, the language seems to be the most important national[23] and sovereignty constituent[24]. For the Qin (in China) and the Roman empires, the Arab, French, Spanish, Portuguese and British colonies, language and writing were the consistent way of communicating across the colonies. The colonial language subsists, at least for official correspondence. The *Indicators* demonstrated the strong correlation between language and the adoption of analogue TV standards. Language is dominant in adopting standards; language is capable of evading geography. This

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[19] Barbarian: from Greek βαρβαρων (*barbarous)* a foreigner, anyone who does not speak your own language.

[20] 'One of a Kind'; see Simon (1981:75,76); Simon refers to Katz 1966:240-82.

[21] Arabic, English, French, and Spanish languages expose colonial inheritance. The Latin influence on the language reveals Rome's control (Spain, ROMAnia, Italy, Portugal). Moreover, regarding France- Ancient Rome affected the Latin in the French language, their **Rom**an Catholic religion and the Napoleonic *Civil Law*.

[22] Thanks to the Chairman of French ANFR, Francois Rancy, for this inspection, in our discussion on 6/7/05.

[23] In 1993 Czechoslovakia turned into two (Catholic) states: Slovakia (83.9% speak Slovak language) and Czech Republic (94.9% speak Czech). In the future, bilingual Belgium (Dutch and French) may head for the sort of Czechoslovakia's divorce: the northern Flemish region Flanders (Dutch- speaking), versus the southern part (French-speaking) Wallonia.

[24] Hungary, Slovenia (*evro*), Latvia (*eiro*), Lithuania (*euras*) fight that 'euro' will be pronounced in EU draft constitution, in their language and appropriate accent.

geographical by-pass may be applied by the international organisations, based on language (e.g. CAPTEF), to promote standards; this is the case of the French SECAM. The language has also an opposite role; due to the language barrier, legal origins, rules and standards could be disregarded and rejected. Interesting that the language itself (not only in English) voices the links among the spheres of influence: for example regulation (descendent of Latin (*rĕgula* rule) and sovereignty *(superānus* superior), policy/ police (from πόλις pólis meaning city, state and citizenship in ancient Greek) and even standard[25]; these relationships are habitual and are part of our cultures.

1.2.2 Social Networks, the Family and the Religion

Some take a country's predominant religion as a proxy for its culture (Licht *et al* 2004:10); some religions and traditions are less favourable than others to economic growth and welfare. Religion is parallel to language in Figure 1-1 the *collective values*' shell. However, the religion has a direct influence on other *collective values*, such as acceptance of authority, education, *risk concerns*, perception of risk, *collective constructs*, geopolitical influence, orientation and state politics (if religion is not separate from it). Therefore, religion can influence policy, *societal and risk concerns*, and attitude toward innovative regulation. There is a high correlation between the regime (directly influencing regulation) and the religion practised by the majority of the population. Risky behaviour can be linked to religion; 'Risk tolerance also varies significantly by religion' (Barsky *et al.* 1997:550). Beliefs function as constraints on the perception and judgments of individuals; religion offers a self-control mechanism to maintain the *social order* (Anderson 1988:1068-9). Although Adam Smith's *invisible hand* assures that markets are efficient to deliver the goods and the services people desire, it tells us nothing about where people desires come from in the first place; if tastes were fixed at birth, this would pose no problem (Frank and Cook 1995:201). Religion shapes beliefs and desires, therefore in many countries free market is not needed, as the market is 'efficient' at filling un-needed desires. Frank's rationale may explain why there is no free-market in many countries, where religion is not separate from state (see Fanfani 1936, quoted by Grier 1997:57). Is there a rational religion free from 'absurdity, imposture or fanaticism'[26]? Is it possible that moral codes are goal-oriented? Are our values intended to achieve any goals? Beliefs (and worldview) bound the rational behaviour of the individual.

The relation of the regulator and decision-maker to his/her father/ mother is rooted in his/her

[25] From *estaundart* Anglo-Norman **flag** displayed on a battlefield so that troops can rally to it; Ayto Dictionary.

[26] Anderson (1988:1074), quoting Smith's 1776/1976:793. Adam Smith did not view all religions as equally irrational; he quotes David Hume *1754–62 History of England* doubting the existence of 'pure and **rational religion**, **free** from every mixture of **absurdity, imposture or fanaticism**'

religion (priest-father), tradition and in the familiar cell; it draws by reciprocity[27] also the citizen- government relationships. This behaviour might shape the relations between national government and the main actors (i.e. regulator – cellular operators); do the players find a mother-home in the regulator office, or is the regulator another player (concurrent-brother/sister)? The approach of the individual toward the government (and that of public servants toward decision-makers) is entrenched in religion, which defines his/her attitude toward the superior-sovereign-*superãnus-суверенной-souverän*, toward parents, family, patron, city, state, king and God. The relation to the *superãnus* (elder, teacher, tutor[28], commander, coach, boss, manager, chief, supervisor, and leader) is ingrained in a person's relationship with his/her father/mother. Therefore, the religion, entrenched in his/her nuclear family, forms the individual interaction with the group and the collective, identifies his collective action, cooperation and relation to the State.

Religion affects the *regulatory frameworks*, *societal and risk concerns*, *risk tolerability* and managing for innovation. Therefore, countries' attitudes can be clustered by their religion: e.g. the Protestant *individualised market-based* Australia, Canada, New Zealand, UK and USA. In contrast, the relations between the interests of society, 'when seen as a whole' (Simon 1981:170, citing Jan Smuts *Holism* 1926), are a key-point when implementing the *collective* regulation policy and adopting *universal* standards. Catholicism- meaning 'the whole'- may embrace Holism, *central-planning* and social solidarity.

Protestantism's fundamental insight is that the relationship between the believer and god matters above all; a direct link between the centre of Figure 1-1 the Individual and outermost circle God, to enlighten the value of Individualism and 'whatever is not forbidden is compulsory'. In contrast, Catholics hold that the relationship between believer and church is almost as important, and that the church acts as hierarchal intermediary between believers and God. The Catholic dogmas and rituals may be reflected in '*guilty* until proven *not-guilty'*, worst-case assumptions and the 'command and control' *civil law.* In addition, the maps of north and south Europe and North and South America follow the contours of Protestantism and Catholicism; this reflects and may explain the difference between the *individualised market-based* North and the *collectivised central-planning* South.

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[27] See Hood et al. 1999 about reciprocity (p. 190) and the mutuality (pp. 45,189).

[28] Emphasis added: 'Pope' originates from Latin: papa, **tutor**; from Greek *πάπας* (papas); **father**. The Aristotle choice theory and *social order* 'an obedient and chastened state: as the child should live according to the direction of his/her **tutor**, so the appetitive element should live according to **rational** principle (Aristotle 350 BC/1976 *Nicomachean Ethics*: chapter 12).

1.3 *Social Networks* and the City

Figure 1-1depicts that the *societal and risk concerns*, perception of risk and its acceptable levels are affected at a city level. Like the relation of the individual to his/her parents, the city shapes the relationship between citizen–state and vice versa. Cities are often personified as mothers[29]. The city is the origin of **citi**zenship, state and nationality not only in English[30]. The place of living and working[31] inspires the worldview and rationality of the individual and decision-maker. The city provides the education, the attitude to property rights and enforces these rights. The city represents some *collectivism* among the citizens[32]. Law, regulation, court of justice and police[33] border and bound the individual freedom; the boundaries of an organisation might be more instructive than the substance itself[34]. In a '*laissez-faire*' regulatory framework, the only role of the city (and the state) is to serve the individual, and provide him/her with an appropriate framework (protecting life and property) with minimum intervention. The splitting of local leadership may create a culture of provincialism/ fragmentation and not integration. 'Concrete manifestations of culture such as attitudes towards the government, levels of trust and a general level of social capital can provide the conditions for development of media self-regulation' (Programme in Comparative Law and Policy 2004:80). The 'social distance' (Smith 2002:539) and the 'social exchange' are mainly carried out in the city/ province/ tribe shell. The political culture in the city might define the citizens' attitudes towards the government, organisation of social, community networks and even toward *risk concerns*. Most of the disputes about the installation of cellular masts and electric pylons are in the city level; some localities set exposure standards more stringent than official guidelines, and prevent towers being erected near schools; a typical debate about local versus national control. However, above the city, the State law (or constitution) binds the rules of the city, e.g. the limits of RF *spurious emissions* (and regularly *human hazards*) levels.

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29 'City and Mother' is mentioned in the Bible Samuel B 20, 19. One of the names of Jerusalem is עיר ואם a 'city and mother'; 'Holy **city is mother** of all churches' Pope John Paul II 28 Nov. 1997, visiting Jerusalem. The earth and nature are also presented as mother.

30 *Staatsbürgerschaft* in German, *ciudadanía* in Spanish, *cittadinanza* in Italian, *citoyenneté* in French, гражданство (grad) in Russian. In Arabic, *Madina* is city; *Yathrib* became Al Madina 'the city of the prophet'; *Madina* المدينة in Hebrew המדינה is State; both words are derived from (din) دين-דין judgment

31 Citizens living close to cellular towers may express opposite views compared to those engaged with the cellular industry.

32 '*Concordia Civium Murus Urbium*' The harmony among the citizens is the wall of the cities.

33 Police, policy and politics are derivatives of the Greek word *πόλις* (*pólis*) meaning city - state; see Ayto (1990) *Word Origins*. This may explain why the Police 'establishes and enforces' the limits of the city and state.

34 The bagel is the boundary, and it is the substance. Sometimes the process, the framework and the boundaries are more important than the matter.

1.4 *Social Networks* and the State

Regulators within government share the authoritative power of the State (Hood *et al.* 1999:66). The ways in which regulators behave tend to be linked to the Relational Distance (RD) between regulator and regulatee (Hood *et al*. 1999:44,60). The central theme of 'relative distance' concerns whether those regulating and those being regulated share a common professional or social background (Hood *et al*. 1999:200). RD might be crucial to regulatory operation for the perspective of grid/group typology of *Cultural Theory* (CT), since it represents social cohesion and the differentiation of one group from another, which is one of the fundamental coordinates for human organisation in CT (Hood *et al.* 1999:60). The mutual relation of regulator-regulatee may be related also to the 'mutuality' public management type of control. Figure 1-1 depicts the social bases of control and oversight. Control by definition must contain some method of setting standards (Hood *et al.* 1999:45).

Countries can be unified by common interests, common political views and even common dislikes. The decisions are inspired by the decision-maker's worldview, the government policy and the country's culture. This explains why scarce resource allocation and licensing can be explored through cultural prisms and rationalities. One approach to studying governments' regulatory behaviour is to adopt the metaphor that 'a government is an individual, having explicit objectives and choosing among alternative actions on the basis of their expected contributions to government goals' (Noll 1982:9).

The organisation of a society itself reflects historical, cultural, social, political and economic processes (Greif 1994:944). The RF regulation is established at a national level. In homogenous national societies (such as Japan and Taiwan) the citizens share in their geographical territory the same language, religion, philosophy[35], ethnicity, history, tradition, ideology, goals, values, desires, beliefs and preferences. Homogeneous countries apply *harmony of interests* (Adam Smith 1776:678)[36]. The basis of the national regulation is shaped by the parents at home. The homeland *patria*[37] reflects the basic value of mutual responsibility, among the members of that society (Greif 1994:923); 'no enlightened nation is born except from the womb of the feminine/mother' (Grosbard 2007:25, citing Khalaily Samir). The common elements to the state are frontiers, geography, sense of belonging, currency, economy, industry, technology, human rights, political regime and legal

[35] Walpola Rahula asks (in the foreword of Rahula 2001) if Buddhism is a religion or philosophy? It is difficult to separate religion and philosophy also in Judaism and Islam.

[36] Adam Smith refers in *The Wealth of Nations* to Plato, Aristotle, Polybius and Montesquieu (volume IV, chapter II) stressing the role that the "invisible hand" played in attaining a 'harmony of interests'.

[37] Patria, patron and pattern have the same root as father; the etymology of father is Greek *πατερα* and Latin *Pater*: Augustus was *Pater Patria*; it appears on an ancient Roman coin around Augustus' profile.

framework. In this social scenario the decision-maker is the patron (see 'patronage', Hood *et al.* 1999:82), that should integrate the worldviews of individuals and the society, to lead the scarce resources allocation, risk policy and standards' adoption.

Is the state a frame or a substance? The state is the frame- a tool to serve the individual; or, the state is the substance- an aim, which the individual should serve. Montesquieu[38] argued for the sovereignty of a free society to gain freedom for the individual. When considering priorities and relations between the competing interests of society and the individual as regards regulating uncertain risks, we may refer to the paradox of a free society and the freedom of the individual, which was emphasised by Niccolo Machiavelli: 'we can only hope to enjoy a maximum of our own individual liberty, if we do not place that value above the pursuit of the *common good*' (Shaw 2003:48 interpreting Machiavelli 1517). The rules and standards reflect the different rationalities and characteristics (such as risk aversion) of the decision-makers.

Colonialism categorises the frontiers, language, religion (influence of missionaries), geopolitical influence, legal framework and regime. The colonisation defined the initial conditions, the boundaries of the present state of affairs and the situation. In many countries, 'positive colonialism' characterises the e-Communications. Colonies preserve the regulatory framework and commercial links to the 'conquering' motherland.

Social Networks, the State and Legal Origin

"The legal origin is a useful instrument for formalism" 'Djankov *et al.* (2003:8). Where there is *trust*, informal regulation is sufficient (Hood *et al*. 1999:163); trust between regulator and regulatee is more typical to *common law*. Regulators appear to facilitate and reinforce a culture of litigation against public authorities (Hood *et al*. 1999:204). The systems of law by which the countries are governed define the interrelation of sovereign and subject; the law protects the individual against arbitrary power. "Understanding of the past is essential for understanding today's law' (Lerner 2004, quoting Zimmermann 2001:100,110), and understanding the present regulation. *Civil law* has its origins in Roman Law, especially the *Corpus Juris Civilis*, via the German civil code and the Code of Napoleon; the *common law* evolved in England from the principle of individual liberty found in the *Habeas Corpus*[39] Writ. *Civil law* metaphorically may stand for the proposition that you may do whatever the law permits; therefore, the law governs all aspects of life. *Common law* predominates in the

[38] Montesquieu 1748/1989 part I, block, I, ch.3 p.8; see also Venturelli 1998:190.

[39] *Habeas Corpus* (HC): you should have the body; HC entered the *common law* through the Magna Carta; HC is also stated at Article I, Section 9 of the US constitution.

UK and US; it figuratively proposes that you may do whatever you want, unless the law prohibits it; therefore, the law delineates the bounds of human activity.

The national legal origin (*civil law* versus *common law*) may cause differences in regulation, as most developing countries have inherited much of their legal procedures (and regulation) from their colonisers. Based on a World Bank study of 109 countries, the conclusions of the Djankov *et al.* (2003:37-8) are that procedural and judicial formalism, interventionism and bureaucratic inefficiency are systematically greater in *civil* than in *common law* countries. Procedural formalism is associated with higher expected duration of judicial proceedings, more corruption, less consistency, less honesty, less fairness in judicial decisions and inferior access to justice. The 'Lex Mundi Project' (Djankov *et al.* 2003:12) indicates that legal traditions have been derived from Roman (*civil law)* and English law (*common law)* respectively, were transplanted to many countries through conquest and colonisation (by France, Germany and Spain in the case of *civil law*, and England in the case of *common law*), and were preserved throughout the centuries. The Project links the different levels of trust (2003:13) and sovereign control (2003:15) to the legal origin; there is less trust and more control in *civil law* than *common law*. The legal origin is linked to the religion (see *Indicators*); it may be said that Catholicism might shape judicial formalism (2003:31).

The differences between French *civil law* and UK *common law* may be unbridgeable in mentality and outlook (Legrand 1997:45). Economists related rational maximising behaviour to the *common law* (e.g. Rubin 1977 *Why is the Common Law Efficient?*). The *common law* (representing the individual) affords higher authority to the law than the State (or King), as a barrier to the excessive power of the State (or King; see Smith 2002:530). The priorities of *civil law* are different. Regarding trust versus precaution against risks from cellular masts and electricity pylons, the '*innocent* until proven *guilty*' approach could be linked to *common law* (compare to subsection 1.2.2, relating it also to religion). The supremacy of the national law (versus religion or super-national law) is not only a legal theme, but also a cultural one; nations may compromise their sovereignty in RF harmonisation; however, legal system is renounced with more reluctance.

1.5 *Social Networks*: Super- Nationality, Globalisation, 'Nature or God', Environment and Science

The relative national power, the character of the State and the strength of its industry determine the process of harmonisation and creating a single market. The legislative powers of the State, its sovereignty and the administrative tools available in enforcing regulation differ among states. Culture and sovereignty are barriers to joining a super-national organisation. The capability to unify laws and create supranational and sub-regional institutions, such as EU (European Union) and *CAN* (*Comunidad Andina de Naciones*) depends on the regimes of each country, their development status, their *risk concerns* and to conceding some of their national sovereignty. Surrendering sovereignty is unusual; the European case is unique. *Bounded Rationality* also restricts harmonisation. A supranational view endorses harmonised laws and common RF allocation. The regulation and standards are created generally at a super-national level (such as EU and ETSI); they reveal the *collective values* of the society, geopolitical influence, *societal and risk concerns*.

Geography and colonialism bound the rationality; they present the initial boundary conditions. The geography of the country defines which culture dominated the continent and which empire ruled over it; geography classifies topography, isolation from neighbours, distance from the sea and verticality. The geographical position and distance from influencing powers (e.g. Mexico and Canada from the USA, Belgium from France) also classify the regulatory framework. Countries try to promote harmonisation agreements with their neighbours. The distance from the Equator is also significant; the latitude categorises the climate. Temperate zone countries tend to economic convergence, through rapid diffusion of technology, but tropical ecological zones tend to differ (Sachs 2001:22). Super-nationality and globalisation tend to discourage nationality and sovereignty. Homogenisation contradicts the individual's unique expression and the national regulation. Harmonised wireless equipment and global networked services search for the worldwide denominator and lose the unique characteristics of the generation-to-generation and nation. The evolving process of EU integration and Pan-European assimilation shadows national identity. However, the codified worldwide approach may provide an appropriate, stable framework where nations may express their exclusive culture and technology.

Political science is necessarily a historical science; what will happen next is not independent of where the system is now (Simon 1985:301). Ancient Rome might be seen as the spirit of the European Community (EC). The Roman Empire (*E Pluribus Unum*) may in this way inspire France and Germany to unify Europe (perhaps under their hegemony), while the UK relative isolationist policy and the local patriotism of the Andean Community support a national policy. Regarding the three cultural attributes of the thesis, Ancient Rome is the source of the language, religion and legal origin of the Western world. The Roman Empire is the universal dominion, multicultural (many religions), centralised by the *Lex Regia*[40], assimilating and not dominating colonies (the citizens from a legal point-of-view are part of

[40] An ancient law: all the rights and power of the Roman people were transferred to the Emperor (Stephen 1824:14). This centralism and supremacy of the State are typical to the *civil law* and the collectivised countries.

the Roman City itself), well networked (all roads lead to Rome), seeking peace (*Pax Romana*, the Roman Peace); one Caesar (emperor) governs the super-nation; Rome shares one single market, one executive language, with one currency and one law. Rome seems to be the *ego-ideal* of the EC. In a similar way, the Incas and Bolivar influence the Andeans countries in South America: e.g. *CAN* states may follow the path of Simón Bolivar, in unifying again a *Gran Colombia* (great Columbia).

Globalisation influences the worldwide regulation; it is a universal process. International organisations such as the World Bank, World Trade Organisation (WTO), World Health Organization (WHO) and ITU play a significant role in developed and developing countries, bringing together governments. WTO implemented the challenge for 'specialized super-national regulatory institutions', by the agreement of 69 countries to a policy of telecommunications liberalisation in 1997; the WTO 'Reference Paper for Telecommunications' also contributed to the liberalisation policies (see Ecuador *case study*). WHO defines the *human hazards* thresholds, serving as the reference level for all countries. Today, international organisations guide developing countries in particular toward liberalisation through privatisation and deregulation. ITU facilitates the communication infrastructure and determines the global RF allocation. Regulators are faced with accommodating multinational companies, demands to permit quick-to-market applications and the need to harmonize globally to facilitate economies of scale. Free circulation of mass wireless equipment (like cordless telephones, door openers, Wi-Fi and Bluetooth) and networked services (like GSM) oblige a globalisation of the RF spectrum.

A direct link between the father and God exists in Judaism אבינו שבשמיים (our father in heaven) and within Christianity: the doctrine of the Holy Trinity states that God exists in three persons: Father, the Son and the Holy Spirit. The statement of Wolfgang Amadeus Mozart, 'after God, father'[41] may indicate his view about the superior authority (above God) and the driver of his genius. The passion activists, fighting to preserve nature (and environment), can be compared to the pray. 'God or Nature' is contrasted by Douglas and Wildavsky (1982:123,127,137); we may distinguish 'our father in heaven' from 'mother nature'; 'God or Nature' are the two conflicting arbiters, external to the large-scale social systems, called upon to justify rightness. Ball and Boehmer-Christiansen (2007:558) illustrate the inconvincible 'tinkering with **nature**' or 'playing **God'**. Schwarz and Thompson (1990) title it the 'myth of nature'. The environmentalists and the religious orthodox attack programs 'on behalf' of "Nature or God" and "Natural or Divine ".

The environmental contest is to protect nature against global warming, oil and resource

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[41] Siepmann J. 2002:25 *Mozart-His Life and Music*; translated to Hebrew by Abarbaya; TelAviv: Matar Press.

depletion, power plants and nuclear wastes. In this thesis, the objective is to protect both human (*hazards*) and RF health (*spurious emissions*). Moreover, the spectrum is a natural resource and should not be polluted, just as air, water and earth should not. Rayner and Malone (1998:273) classify climatic improvement as ‘a public good’, since it meets the two formal criteria of non-rivalry and non-excludability; *spurious emissions* and *human hazards* are also located within this domain. Moreover, states define RF bands as common-goods of the public and for the public with the status of being unlicensed and unprotected. The ‘Precautionary Principle’ (PP) links the environment to science; in the 'Rio Declaration 1992' it is listed as Principle 15, “Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation" (emphasis added).

Science is another *collective value* in the same hierarchy as nature in Figure 1-1. Science plays a major role in regulating uncertain risks, such as RF *human hazards*. Science may bridge the North-South divide; Friedman, Dunwoody and Rogers (1999:110) ask "will Western science truly be the ongoing gift of the West to the East, of the North to the South?"

1.6 Social Context- Summary

The relations of the individual in his/her nuclear family are typical to every culture; the interactive social context of the citizen with the hierarchical authorities forms the national regulatory framework. The *social order*, depicted in Figure 1-1, indicates the sources of the *central-planning* versus the *market-based* approaches, the origins of the *Bounded Rationality* and the values and instincts of the *Rational Field Theory*. The figure links the *social institutions* to the *collective values*. The *common understanding*, *common knowledge* (in Latin *argumentum ad populum), collective unconscious, collective constructs* and *cognitive structure* determine the approaches to allocating scarce resources and licensing. Culture shapes and illuminates the styles of wireless regulation. The fundamental attributes of language and religion are the most basic cultural elements formed in the nuclear family. They endorse confidence in adopting standards and 'mimicry' of rules on the one hand, but like frontiers, they also create barriers in ruling and adopting (ignoring and rejecting) standards. At a state level, the legal origin may guide regulators toward different rationalities in their behaviour regarding *societal and risk concerns*. The social context and *collective values* may explain why the same countries show similar responses to different RF risky situations (e.g. permitted RF radiation from cellular base stations and electric lines, and *spurious emissions*). Language, religion and legal origin bound the rationality in innovative ruling, regulating uncertain risks and adopting standards; passion, hate and distrust are also factors in rejecting standards. The social networks also indicate the source and amplification of passion and 'irrational': is the hate to other country and discrimination of standards rooted in the state level (such as toward the US in Venezuela)? Or is the nuclear family and education the source of detestation (such as towards Japan in South Korea)? The spheres of influence define how hate is spread through top-down rules, or via instincts and education.

Figure 1-1 also designates the 'rational' order: the outermost circle is the superior authority; the source of the collective power; regulation and standardisation is created in the higher social institutions; they control and command the inner circle; e.g. ITU allocates RF for EU, and EU regulates for the State (homeland). The outermost shell of the *collective values* - God (father) or Nature (mother), environment and science - establishes (and judges) what is true/ rational/ natural/ correct/ legal / loyal/ authorised / official, and what is not. The shells shape their inner circles, e.g. the legal origin may shape the perception of risk, and the religion forms the cultural beliefs. The dispute within the *social institutions* is the weighting and the priorities; for example, the weight of scientific evidence about RF *human hazards*, or the harm caused to nature and environment by cellular masts. As the *collective values* define what is rational, they also generate the *Bounded Rationality*. The *social networks* assist in explaining why culture influences RF allocation, licensing and *risk tolerability*.

2 Cultural Theory (CT)

Regulatory accountability needs to be understood in the context of cultural variation and bias. Cultural variety and clashes of different worldviews merit attention. Persuasion is linked to culture, and culture is linked to beliefs about the consequences of social action.

2.1 CT Basics - Four Myths of Nature

Cultural Theory (CT) is the theory used to explore the different rationalities and characteristics of nations and decision-makers. The basics of CT are that we are different, '*Divided We Stand*' and therefore should take into account that others have different views; each actor is rational, given his or her own convictions, as to how the world is (Schwarz and Thompson 1990:6). Countries take different approaches to regulation, *societal concerns* and life satisfaction; e.g. 'in Confucian cultures, such as China, the ideal level of life satisfaction is considered to be neutrality; Latin nations (Spain and Colombia) prefer strong satisfaction' (Diener and Suh 1999 443-4). The regulation of scarce resources and uncertain risks is rooted in worldview, as explained by the *social networks*. We may explore and estimate restriction on choice and four such rationalities in this grid: collectivised and equality. The terms grid and group come from Mary Douglas and Aaron Wildavsky (1982) and refer to the degree to which one social group stands out from another (Hood *et al*. 1999:197). The four distinctive decision-makers' rationalities of CT (*hierarchist*, *egalitarian*, *individualist* and *fatalist*) shape the RF *societal and risk concerns*; CT explores the regulation of uncertain risks (*human hazards* and *spurious emissions*). CT clusters and categorises countries with similar attitudes to innovation, *societal and risk concerns*, providing an overall view of cultural predispositions. The attitude of the national regulator to risks and hazards is essential; the *risk tolerability* and reasonable practicability level classifies the regulation. The national-view of protecting the common good and regulating uncertain risks defines the *regulatory frameworks* and *societal concerns*. The national position towards innovation, the individual role and rights implies the variance of regulation. The *Cultural Theory* was applied to: illustrate the vulnerability and tolerability of the earth; compare voluntary risks versus involuntary risks; evaluate the risk perception, *social amplification* and attenuation.

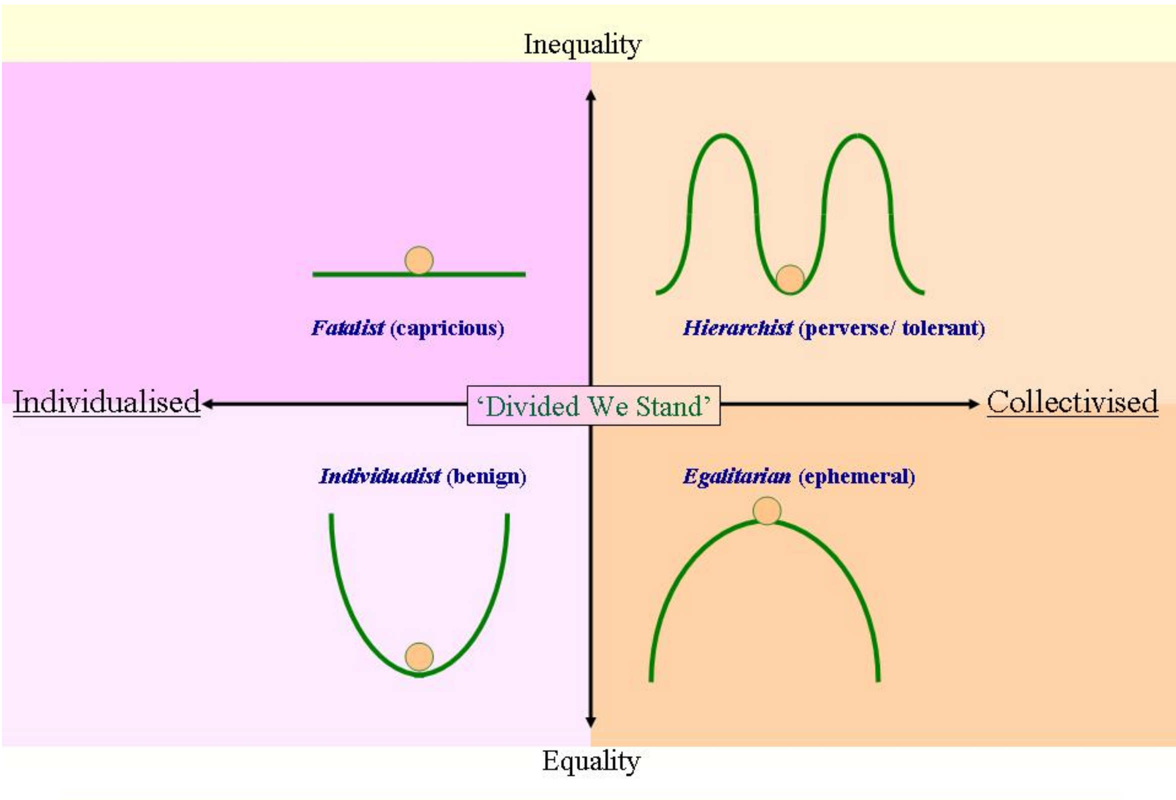

Figure 2-1 Typology of the four perceptual filters[42]

Figure 2-1 depicts the four myths of nature in CT; they may explain the different views in assessing *societal and risk concerns* and qualify the choices made by regulators. CT brings us to groups of decision-makers. “Who are we?”, “what is our national identity?” and “how should we regulate?” are questions that can be analysed. The role of the *fatalist* (Nature capricious) is interesting. It may be agreed to eliminate the *fatalist*, as he/she does not contribute to the solution (i.e. he/she will not vote); it is often said (including by Michael

[42]Schwarz and Thompson (1990:5) and Ball (2002:App. D) use a similar figure.

Thompson and John Adams, CT experts) that *fatalists* are hard to locate, do not appear to exert much influence and perhaps only rarely exist.

Based on the four perceptual filters, Table 2-1 describes the characteristics of four decision-making perspectives[43]. The last two rows (relating to the handling of scarce resources and attitude to rationality) and the last column (*fatalist*) do not appear (*forgotten*?) in Rayner and Malone (1998:361); the last column '*fatalist*' (mentioned in Adams and Thompson 2002:26) represents the '*forgotten groups*' and the '*omitted voice*' (see Graham and Wiener 1995:230). The primary task for the *harmony of interests* (Adam Smith 1776:678) is to ensure that all four voices are heard in the wireless debate; failure to include all four perspectives is likely to lead to unbalanced decisions.

Table 2-1 Characteristics of decision-making: four perspectives

	Hierarchist	*Egalitarian*	*Individualist*	*Fatalist*
Myth of Nature	Perverse/ Tolerant	Ephemeral	Benign	Capricious
Human Nature	Sinful	Good and malleable	Self seeking	Indifferent, isolated
Management Type	Control	Prevention	Adaptation	Ungoverned by law
Driving Value	Stability and loyalty	Equity and equality	Growth	Erratic events
Attitudes to Needs/ Resources	Rational allocation of resources	Need-reducing strategy	Expand resource base	Humoursome; not important who you vote for
Risk	Risk Accepting: acceptance of some risk	Risk Averse: non-acceptance of risk; '*guilty* until proven not-*guilty*'; worst-case scenarios	Risk Seeking: propensity to take risks '*innocent* until proven *guilty*'	Risk neutral: is not interested in the risks
Handling the Allocation of Scarce Resources and Networked Services	Judgement; loyalty cautious and against excluding the other three perspectives; resource should be managed, science to predict; regulation; intervention to ensure that thresholds are not exceeded; regulators are the Plato philosopher-king; long-term investigations	Top down regulation; bureaucracy; stability, objectivism; the individual is part of the group; holism, Catholicism; cautious; obeisance; fairness in sharing the resource; democratic spread[44]; equal rights to access the resource; Research and Development; favours strong service providers	Innovation, self Regulation; subjectivism; anything goes; individual is the centre of the world; government and the resource are commanded for human benefit; free market; oppose regulation; positive lessons from unregulated Internet; short-term	The way the world is or should be; Deregulation and Licence Exempt to all services (like Internet); so what; *que sera sera* (What will be will be); *carpe diem* (Seize the day), roulette-wheel; agnostic, sceptic; what's the use
Attitude to Rationality[45]	*Procedural/ Bounded Rationality*	*Critical Rationality*	*Substantive/ Objective Rationality*	*Fatalism; non-rationality* (?)

2.2 Four Cultural Prototypes Merge to Two Perceptual Filters

Four cultural types can form the basis of analysing and designing regulation. Hood converges the four typologies into two types of organisations: Centralised (Oversight and

[43] The Table is original; see also Rayner and Malone (1998:361) and Adams and Thompson (2002:26).

[44] E.g. to spread bus stations and cellular base stations uniformly, without gauging public opinion (NIMBY).

[45] Based on Schwarz and Thompson (1990:7) and some ideas from Herbert Simon (1985).

Mutuality - the *hierarchist* and *egalitarian* types), versus *market-based* (Competition and Randomness - the *individualist* and *fatalist* types). Regarding *regulatory frameworks*, the research will join the equality grid and use the typology of only two rationalities: *collectivism/ central-planning* versus *individualism/ market-based;* see the underlined terms in Figure 2-1. Many forms of regulation in government involve hybrids of these two generic types (namely an oversight linked to competition or mutuality or randomness) (Hood *et al.* 1999:45). Ayn Rand (in her novels *We the Living* 1936*, Anthem* 1938 and *The Fountainhead* 1943) identified 'the individual versus the collective' as her political philosophy.

The cultural variable 'individualism' (contrasted with collectivism) correlates highly with the national wealth (Diener and 1999:439-44). The merging of the four perceptual filters to only two rationalities focuses and converges the decision-making and the regulation of uncertain risks. The two collectivised (*hierarchist* and *egalitarian*) approaches characterise the *central-planning* rationality, while the two individualised (*individualist* and the *fatalist*) types are merged to represent the *market-based* regulatory style. So, for some evaluations in this section and the next chapter, the *individualist* and the *fatalist* countries are combined to create the *market-based* rationality, the *hierarchist* and the *egalitarian* types are joined as collective *central-planning*: two independent rationalities. The *Case Studies* and *Indicators* chapters pointed out that the relation of State to Market is the most important factor in regulating wireless uncertain risks. The regulation objects that are examined in the thesis relate to the clash between individual rights and utilitarianism (Seedhouse 1997: figure 9), the conflicts between personal conviction and institutional obligations.

The opposing collectivised and individualised rationalities formulate regulation of uncertain risks, each contrary to the other: *central-planning* is more risk averse, whereas the market based is risk seeking. Competition is desirable since prices are thus lowered and quality of services is improved; however, *market-based* solutions and competition also present disadvantages to society. It is difficult to quantify the value of scarce resources; unregulated competition may ruin them. *Central-planning* is essential to protect scarce resources: the *market-based* solutions may damage our beaches, forests and land spaces; public broadcasting services should not have to compete with cellular service providers in tenders for the purchase of frequencies. Competition may lead to wasteful duplication of resources: for example if regulators insist on separate transport and e-Communications infrastructures. There are two possible methods of allocating and licensing wireless networks: *a priiori*, relying on a negotiated plan based on a general formula or criteria for seeking **equity** among all the parties; and *a posteriori*, the case-by-case approach based on experience and demand (Codding and Rutkowski 1982:252). The *a priiori* method corresponds to the top-down collectivised worldview, while the *a posteriori* mode fits the bottom-up individualised worldview.

Table 2-2 and Table 2-3 mainly state the advantages of each style, in the philosophical context and contrast of ideas; the next two chapters will refer to these tables in order to explore the role of the state and the market in wireless regulation and standards: explicit control versus the free market. The tables will serve to explain the empirical results and to qualify the interpretation of the data. Table 2-2 and Table 2-3 characterise each cultural style: they classify the countries in general[46] and provide the two main categorisations; moreover, the tables provide a criterion to categorise regions and countries: their regulatory style. Any element in the table has a consequence in the wireless framework to explain the empirical results. Culture forms the wireless framework, whether Collectivist or Individualist. Regulation is either controlled or market-oriented; worldviews are polarised to equality versus competition. Regulating uncertainties extends into risk-averse versus risk-seeking approaches; in this case, the four cultural types are clearer: *egalitarians* would be risk averse, *hierarchists* would be risk optimisers (i.e. seeking the optimum balance between risk and safety), *individualists* would be risk-seeking and *fatalists* would not bother. Plato's "philosopher-king" fits the *hierarchist* contestation of regulation: it is only right that those with superior insight and virtue should make the decisions (Adams and Thompson 2002:26).

2.3 Cultural Theory - Summary

Divided We (and Administrations) *Stand*. The four myths of nature in CT may explain the different views on assessing RF risks and hazards. There are many sociological perspectives on risk of which CT is but one that analyses risk in regulation. Amongst our ostensibly technical criteria, there are other criteria that people in different cultures might judge differently. CT is the tool used to distinguish between national administrations by culture. The CT perceptual filters place the four views of regulation in a two-dimensional matrix, comparing the four different cultural types (*hierarchist*, *egalitarian*, *individualist* and *fatalist*). *Central- planning* versus *market-based* approaches are derived from and are part of the CT; the research classifies the RF regulatory framework countries by those that are *collectivised* versus *individualised*. Tables 6-2 and 6-3 (the European *central-planning* versus the US *market-based*) in the *Case Studies* and Tables 2-2 and 2-3 (in this *Theories* chapter) describe the advantages and contrast the two types of regulator: *central-planning* versus *market-based*. All aforementioned factors are related to *regulatory frameworks*, *societal and risk concern,* as regulation reflects the society's culture.

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[46] There is no country matching to all characteristics; it is a theoretical attempt to cluster the empirical results.

Table 2-2 Collectivised *central-planning* versus individualised *market-based*: ***central-planning*** *egalitarian and hierarchist* perceptual filters

Ideology, Policy, Rationality	Regulation	Worldviews, Values, Goals	Regulating Uncertain Risks	Network Services and Public Assets	Illustration
Collectivism; public interest; group welfare; harmonisation; directing body; commons-based regime; tradition; *civil law*: equity, Roman Law; environmentalism; sense of community; patronage. *Harmony of interests.*	Hierarchy; 'command and control'; equal communications; bureaucracy, centralised; top-down governance and technology; formalism; interoperability and roaming; static allocation; scarcity; Coordinated Market Economies; power to the state, national control; consensus; rules of instruction; some delay.	Equality/ Fraternity/ Liberty; social justice and values; order, responsibility, authority, experience; loyalty; solidarity; research and development; long-term national goals; *collective constructs* and action; the regulator is the patron; Catholicism: universalism, divine providence, brotherly love.	Risk averse; worst-case assumptions, optimising by risk assessment; consumer health; interference coordination and guard bands; precautionary principle; conservatism; rights and licences, subpoena -style; *ex- ante* (licence in advance); sustainability, stability; social past and social future are balanced; 'nature-society'; suspicion, 'guilty until proven innocent'; better safe than sorry.	Control prices and services; licensing with exclusive rights; economy of scale, standardisation, non proprietary and non patent rights, top-down technology; group-oriented; scarce resource belongs to the country; administrative assignments; *a priiori* ruling; better sharing; Quality of Service; common good and collective utilitarianism; the view of the strong players.	Cathedral planning, *common understanding* and knowledge; GSM, Leviathan; philosopher-king; one best solution; standards; *collective unconscious*; licence, intervention; *homo hierarchicus;* engineer; harmony; protective parent; the needs of the many outweighs the needs of the one; Ecuador and France (see next 2 chapters); common future; Roman Empire; Socialism, left-wing. Serve the collective. Tribe, Kibbutz.

Table 2-3 Collectivised *central-planning* versus individualised *market-based*: ***market-based*** *individualist* and *fatalist* perceptual filters

Ideology, Policy	Regulation	Worldviews, Values, Goals	Regulating Uncertain Risks	Network Services and Public Assets	Illustration
Individualism, Freedom; natural selection; pluralism; the licensees should be trusted; human interaction; public consultation; feedback loops; look forward; *common law*: individual property rights, ownership; excellence; Industry; *laissez faire, laissez passer*.	Market mechanisms, light touch; simplification; deregulation, self regulation and self management; full liberalisation, bottom-up governance, technical neutrality; informality, transparency; flexibility, choice and diversity; favours small businesses; dynamic allocation; new technologies to end scarcity; local control; Liberal Market Economies; favour the citizen; fair-play; hurry.	Competition and Efficiency; Liberty; incentives; 'inequity is normal, healthy and moral'; individual innovation; spontaneous; survival of the fittest; the regulator is the public servant, inspector-free; **change**; separation of Religion and State; 'Protestantism': Reformation, Predestination, own responsibility.	Risk prone ; spread risks; some amount of interference; specific evidence, Prudent Avoidance and science-based risk assessment; adaptation; more licence-exempt; *ex-post* (retroactive action, only if needed); growth, progress; economically viable solutions; short-term, present; technology-society; trust, 'innocent until proven guilty'; hypothetical 'phantom risk'.	Controlled by private-sector; free market; competitive; bottom-up technology; individual-driven; open network; allocation to the most economic; minimum price to the end-user; RF resource is a property; *a posteriori* ruling; secondary market trading (as a private good); low access barriers to scarce resources; consumer sovereignty and constrained optimisation; the view of the individual, entrepreneurs. The regulatee is involved in preparing the rules.	Bazaar; medieval cities; invisible hand, WTO spirit; free rider, Robinson Crusoe; Okham's Razor; Internet/ open-source, Wi-Fi; R&TTE; *liberum arbitrium* and *caveat emptor*; *homo œconomicus,* and *homo mensura*; bottom line; economists; Australia, Canada, New Zealand, UK and USA (see next 2 chapters); *carpe diem* (seize the day), what's the use? *Que sera sera* (what will be will be); Capitalism, write-wing. Serve the citizen. Metropolis; *Habeas Corpus*.

The basics of CT have been explored; the characteristics of regulatory perspectives have been looked at through the prism of regulating uncertain risks. CT, the four/two different worldviews will explain the findings in the *Case Studies* and *Indicators*. CT is the appropriate sociological theory of risk to offer an explanation of the pattern of allocation of the RF spectrum; CT provides different *rationalities* to be tested in RF licensing. CT brings us to "plural rationality"; therefore it enables different solutions to be found for the same problem; opposite *rationalities*, whilst each of them is still *rational*.

3 *Bounded Rationality* (BR)

3.1 BR's Basics

The last decades have shown that there is a *Bounded Rationality* even in the economic sciences (e.g. Kahneman 1994:18–36). "Humans are not optimal and only in some cases locally optimal"[47]. There is no absolute truth in quantum physics and in macro applications; therefore, no absolute rationality should be expected in decision-making. Rationality, society and economy are intertwined; market rationality is automatically assumed to derive entirely from individual rationality. The assignment of utility to wealth is an aspect of rationality, and compatible with the general assumption of rationality in economic theory. Traditionally, economic theory has relied on the assumption that a '*homo œconomicus'* (economic person) exists, whose behaviour is governed by self-interest and who is capable of rational decision-making. Economic research assumes that people make decisions in a rational way. The expected-utility theory assumes that consumers process available information according to standard statistical principles; this approach has been formulated axiomatically and is the predominant economic theory for decisions under uncertainty. Classical economics depicts humankind, individually and collectively, as solving immensely complex problems of optimising the allocation of resources (Simon 1981:49). Experimental results have shown that basic postulates in economic theory should be modified. It is important to emphasise that *Bounded Rationality* (henceforth abbreviated as BR) refers not only to individuals - it refers to organisations too; as made clear in Graham and Wiener (1995: 235,237). This is the bridge from the individual BR level to the wide scale, such as diffusion of wireless standards. This section explores the BR of individuals, regulators, decision-makers and administrations. With the aid of the cultural attributes language, religion and legal origin, BR will explain why countries regulate and standardise wireless communications, in a way that is not completely coherent with their goals. Exploring the rationality of decision-makers is

[47] Simon Herbert criticises the Rational Analysis of John R. Anderson; http://ai.eecs.umich.edu/cogarch0/common/theory/boundrat.html 6/1/08.

valuable to this research; BR may provide the *subjective* reasons for *objective irrationalities*. Cultural factors clarify the zone between rationality and bounded rationality; culture illuminates regulatory decisions that seem irrational. Factors of BR affect the wireless *regulatory frameworks*, the RF allocation decisions, the adoption of standards and regulating uncertain risks (RF thresholds). BR fills the gap between the rational decisions and the actual decisions. BR may explain the objective irrational decisions, why regulators do not always act rationally to achieve their goals, and how passion and mistrust bias the decision-makers. BR may explain the anomalous countries in the statistical figures.

The human mind has its limitations: our attention is limited to a serial bottleneck of short-term memory, which causes a great deal of human unreason; we consider only one facet of a multifaceted matter, before a decision is reached (Simon 1985:294-5,302). Because of the mind's limitations[48], humans must use approximate methods to handle most tasks. The psychology of judgement and choice may explain the decisions in diverse domains; intuition and reasoning may provide contradictory results in judgments under uncertainty.

The economist Vernon L. Smith, the Nobel Prize laureate of 2002, stated in 1962 (see also Smith 2002:502) that *objective* rationality is not subjectively rational. The psychologist Daniel Kahneman, also the Nobel Prize laureate of 2002 (along with Smith), called into question the assumption of rationality in some decision-making situations. Real-world decision-makers frequently appear not to evaluate uncertain events according to the laws of probability; people are incapable of fully analysing complex decision situations, when the future consequences are uncertain and the events are random.

3.2 BR's Definitions

Different people, according to their personal worldview, define rationality differently (Ball 2001b.:7). Rationality is a goal-oriented behaviour; rationality is intended but not always achieved (Jones 1998: abstract and p. 4). Rationality also denotes a style of behaviour that is appropriate to the achievement of given goals, within the limits imposed by given conditions and constraints (Simon 1982:405)[49]. Furthermore, rationality is synonymous with the peculiar thinking process called reasoning (Simon 1982:426, citing William James 1890 *Principles of Psychology*). If the characteristics of the choosing organism are ignored, and we consider only those constraints that arise from the external situation, then the *substantive* or *objective* rationality of the decision-maker is a behaviour that can be adjudged objectively,

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[48] In contrast to Buddhism: 'the activities of the mind have no limit' Buddha *ca.* 450 BC/1966:96.

[49] Similar definition: "the term 'rational' denotes behaviour that is appropriate to achieve specified goals in the context of a given situation" (Simon 1985:294).

to be optimally adapted to the situation.

In 1957 the Political Scientist, Professor of Psychology, Herbert Simon, who received a Nobel prize for economics in 1978, proposed the notion of *Bounded Rationality* as: 'that property of an agent that behaves in a manner that is nearly optimal with respect to its goals, as its resources will allow; a behaviour that is intended to be rational, but is only limited so' (Morand and Stagl 2001:6, citing Simon 1985 and Williamson 1998). If we take into account the limitations of knowledge of the decision-makers, we may find them to be incapable of making objectively optimal choices. However, the *procedural* rationality or BR is an adaptive behaviour within the constraints imposed both by the external situation and by the capacities of the decision-maker. To deduce from BR, it is not enough to be aware of the specified goals and situation (in contrast to *substantive/ objective* rationality); we must also know the information about and conceptualisation of the situation that the person has, and his/her abilities to draw inferences from the information he/she possesses. Based on uncertain information and partial ignorance, the *procedural* rationality usually terminates with satisfactory actions, and not optimal courses of action; moreover, the decision is bounded by traditional ways of doing things.

3.3 *Bounded Rationality*: Regulators and Decision-Makers

Herbert Simon showed how to substitute the incredibly clever 'economic man' of decision-making theory with a choosing organism of only limited knowledge and ability (Simon 1955:77). Individual decision-makers seem to have a reputation for choosing irrationality (Douglas and Wildavsky 1982:75). In order to identify "irrational" RF decisions, there is an initial need to define rational decisions. The basic assumption is that for any administration there exists a "rational" way to license and to standardise wireless systems. "Rational" governments regulate the RF spectrum in a consistent manner; "irrational" regulators do not; there might be one "rational" wireless regulation, but many "irrational" *regulatory frameworks* and *risk concerns*[50]. The "correct" national regulatory framework can be indicated by objective factors: cost-benefit analysis, implementing the decisions and recommendations of ITU and regional organisations, the economic and 'social' success of this society (for instance World Bank indicators)[51]. To achieve what is thought to be the "correct" way, the decision taken needs to be the "rational" one; this is not necessarily the "scientific" way. Dorothy Nelkin (1984) (cited by Jaeger, Renn, Rosa and Webler

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[50] Again Tolstoy "All happy families are alike; each unhappy family is unhappy in its own way." Between two points in planar geometry there is only one simple line, but indefinite ('irrational') curves. 'Great minds think alike' (Michaelian).The rationality of decision-makers can distinguish between developed and poor countries(?!).

[51] The author's worldwide experience may assist to indicate 'rational' regulatory framework and RF thresholds.

2001:219) describes science as 'a supermarket for rationalising political decisions; the existence of plurality of scientific expertise, however, jeopardizes the status of scientists'. The assumption of the existence of one rational way is not completely aligned with the multiple-rationality approach of the *Cultural Theory* and the sophistic assumption of “no absolute truth”; but, if the rational solution cannot be defined as a basic reference, how can we refer to *Bounded Rationality*? Our “common sense” directs us to the rational view that “regulation should be focused where needed and rolled back elsewhere”, and that “more sustainable competition, more wireless services and new technologies lower prices and increase consumer choice"[52]. Perhaps this rationale is the common sense only held by the *market-based* rationality? These aims and *collective values* are not obvious to all cultures and states; Cuba has a different view[53]; this opposite rationality is also adopted by Venezuela, which intends to nationalise its telecoms. Actually, regulators call into question the correctness (rationality) of the market: are the agents anonymous? Are there many actors? Do the individuals and organisations behave well? Are the aims and desires sensible (Frank and Cook 1995:201)?

Risk and uncertainty are linked to rationality; the *risk concerns*, perception and tolerability (by the public, experts and decision-makers) are subjective. Regulators tend to ignore issues of human needs and wants, the social bases for cultural or institutional choices, uncertainty, imperfect knowledge, incomplete information about alternatives and irrationality, because they are too complex. Regulators lack information that only regulated firms have (Magone in Baldwin, Scott and Hood 1998:204). There are rational reasons not to regulate. James Gardner March summarizes brilliantly the rationale not to regulate rationally (see Literature Review, *Bounded Rationality* section). If there are cognitive costs in every application, then the effort cost will often exceed the benefits (Smith 2002:503). In addition, if there is 'no rule without exception' *‘Nulla rĕgula sine exceptione’*, the question to pose is: do we really need to make many rules and to be completely rational in regulations? If we follow the teachings of Cultural Relativism, it is impossible to regulate technology and industry in any rational way; since all hazard evaluations and consequent regulations were justifiable, none were; as there is no evidence (and no absolute truth- Protagoras) one could not morally justify the imposition of sanctions (Shrader-Frechette 1991:35).

Regulators seek the decision and strategy that are the simplest, or they translate problems into a canonical representation, the most straightforward translation (Simon and Hayes

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52 According to economic and social judgment, achieving these “rational” goals is also in the interests of those being governed.

53 Based on messages from Moisés Cortés Escobar, 10 Sept. 03 and 16 Aug. 05.

1976:183). It is another aspect of the principle of simplicity and "Okham's Razor"[54]: 'if you have to choose between competing theories, choose the simplest theory, because it is most likely to be true'. Unfortunately, there is no reason to believe that the most accessible features are also the most relevant to a good decision (Kahneman 2002:459). Increasing the number of regulatory institutions and the number of employees may raise confusion, as 'unreasonableness is a problem that increases with the size of groups' (Van de Kragt 1983:112), and the number of the groups (such as the number of wireless regulators in Ecuador, for example).

BR may explain many decisions of regulators that are not absolutely rational. A regulatory system contains a *substantial* element of chaos, for one can never quite be sure which set of rules or procedures will dominate in the end in any particular situation (Ball 2001a.:1). When probing regulatory decisions, the affecting factors (such as cost of intervention, effectiveness, decision rule, public welfare, risk transfer and risk compensation) are not free of politics, value judgements or significant uncertainty. Regulators should avoid 'enclosed rationality' (Ball 2001b;5, citing Adams 1995): the technique is within its own selected boundaries, and is rational according to its own criteria. Forces beyond those boundaries, however, may affect the real world. As the rationality of decision-makers is unpredictable, regulatory policy is another risk for e-Communications actors.

Stretching into the absurd, the BR theory may be misused as a *Deus Ex Machina*[55] to justify irrationalities and non-rational decisions, in regulating RF uncertain risks and standard adoption. Statements such as lack of information ('the intelligence failed'), the situation is not clear, or the future will provide the intended results, may serve as pretexts for irrational and unreasonable decisions. Scarcity is a central fact of life; land, money, fuel, time, attention (Simon 1981:25) and RF spectrum are scarce. The author of this thesis believes that our world is relatively rational; therefore, it is the task of rationality to properly allocate scarce resources, correctly license networked services, properly regulate uncertain risks and appropriately standardise. In addition, Article 1 of the ITU Constitution sets out the common aim of '… improvement and rational use of telecommunications'.

3.4 *Bounded Rationality* (BR) - Summary

The BR indicates a fundamental change in how we observe and model a decision in all its contexts. Rationality is a goal-oriented behaviour; the rationality of a decision is examined

[54] Named after the 14th century logician William of Okham.

[55] 'God of the machine', the title of Paterson 1993; 'out of the blue sky'- describes well *Deus Ex Machina* in the Greek drama: an extraordinary solution turns out to solve complex problems.

relatively to the goals. The limitation of knowledge makes the optimal choices and alternatives unachievable. Cultural factors such as language, religion, legal origin, values, ideologies, beliefs, preferences and interests should be considered when we evaluate the choice and the rationality of a decision; geography should be also considered, as it influences regulation. Rationality itself is not absolute; it is bounded. One would expect that self-interested material incentives would enforce rational behaviour, at least in economics; but recent empirical tests in psychology and economics show that even in economics, rationality is bounded. The choice of criteria for deciding what is rational and irrational is neither a matter of science nor for science. During the regulatory processes, nations and institutions may behave beyond their rational self-interest, in contrast to the self-interest of the main actors. In this BR situation, why should one expect complete rationality of decision-makers? If the public is aware of BR, it may be more tolerant of decisions that seem irrational. In addition, being aware that our knowledge is limited may assist regulators in choosing a particular alternative. However, BR should not be an excuse for erroneous decisions; even in a BR and 'relative truth' atmosphere, we should aim for rational judgements and the right choices.

Nobel Prize Laureates (political scientists, psychologists and economists) contributed to create this inter-disciplinary theory. The reasons -psychological, economic, engineering, legal, cultural, societal, historical, geographical, geopolitical, political and philosophical- causing the rationality to be bounded may explain the rationale (or non-rationale) of many decisions under uncertainties. BR theory assists in understanding the facts when studying wireless regulation among different cultures; BR may explain exceptional decisions regarding the RF *regulatory frameworks*, the *societal and risk concerns*. Issues analysed in this section are related directly or indirectly to the ways in which administrations allocate scarce resources, license networked services of general economic interest, adopt standards and regulate uncertain risks. The BR provides a theory to frame complex problems in the research. The cultural and geopolitical factors may rationalise the apparently irrational (or bounded in their rationality) decisions.

In the thesis, BR explains the present regulatory framework: why different governments made the existing RF regulatory arrangements. In the next chapter, it may be seen that cultural and geopolitical attributes transfer *objective/ substantial* irrationality to *subjective /procedural* rationality. BR defines the difference between the ‘right’ and the actual decision. Wireless *regulatory frameworks* differ, because administrations carry out different rationalities and bounded rationalities. The empirical study uncovered these links; next chapter will explain the irrationalities. The theory of Economics and Cost Benefit Analysis founded the 'rational' decision-behaviour: consider all options, evaluate the expected-utility according to standard statistical principles, weigh up the benefits and costs, and choose the one with the best ratio. The empirical cases provided the exceptional decisions; the next chapter will explain their *objective* rationality. Like *Cultural Theory*, *Bounded Rationality* links *collective values* to *social institutions*; BR will explain the apparent irrationalities, such as discriminating against, instead of adapting to neighbours' standards, inventing rules and superfluous institutions. Similarly to the *Cultural Theory*, BR permits the existence of different *rationalities* in analysing the RF allocation and licensing.

4 *Rational Field Theory* (RFT)

4.1 RFT Basics

There is no judging between lifestyles and moral ends (Douglas and Wildavsky 1982:188), and no reasoning with tastes and preferences (Douglas and Wildavsky 1982:191). The market may not be the most appropriate allocation mechanism; philosophers have pointed out that *values* are in many cases not commensurate on a single scale (Morand and Stagl 2001:5). Government agencies seek to maximize social welfare or the public interest (Noll 1982:13). Knowing that decision-makers are different, their rationality is bounded, and given that they are rational or at least should be, the philosopher David Seedhouse has developed the health promotion tool, the *Rational Field Theory* (henceforth RFT). RFT is applied to analyse *societal concerns*, beliefs and value-judgements. RFT includes philosophical aspects that guide decisions; it assists in defining the objectives for decisions and tradeoffs among these alternatives. RFT illustrates numerous conventions as *rational fields*, products of choice. In the context of *societal and risk concerns*, one can hypothesise that these concerns are the consequence of different stakeholders acting according to different *rational fields*. RFT provides the opportunity for more meaningful decision-making. It enables regulators to plan and act in honesty, using whatever methods are suited to their quest. The underlying premise is that we organise the world around ourselves according to numerous conventions, or *rational fields*. RFT offers the prospect of elucidating beliefs, values and other factors active in decision-making, and may provide a novel approach to understanding and dealing with alternative preferences, for getting to the heart of risk management decision processes, where many of the conflicts over *societal concerns* originate (adapted from Ball and Boehmer-Christiansen 2002:26). RFT explicitly recognises that decisions made by people and organisations are functions of instincts, values and classifications, all of which are operative (Ball and Boehmer-Christiansen 2002:31); the instincts, classifications and values shape the rational field and form its walls (Seedhouse 2002:69). *Rational fields* are interconnected, as none are wholly independent; Koestler's idea (Koestler 1979, quoted in Seedhouse 2002:64) is that any rational field must have at least one distinct purpose and a strategy by which to pursue it. Each part exhibits a goal-directed activity too: problem–solving activity is the essence of a rational field. The RFT shows the structure of the obvious and plans for practice in theoretical clarity (Seedhouse 2002:144).

Engineers provide answers, philosophers ask questions; RFT reveals and illuminates philosophical questions about values and goals in regulating the common good. We hold different views on democracy, the function of the State versus the individual, or what is really important for the citizen-consumer and the welfare of citizens. In Western civilisation the individual stands in the centre of the state and the universe; therefore, the State is a tool to serve the citizen-consumer; it is different in the East, Socialist and non-Democratic countries. How should one decide what is important in utilising a scarce resource, in adopting standards and what is dangerous? Should we aim for "*homo sapiens*" (reasonable person)? Should regulation assume '*homo œconomicus*'? Do we need equity in the RF allocation or installation of cellular base stations? When and how should the regulator intervene? Which method is better: *central-planning* or *market-based*? Which hemisphere should be preferred in RF standardisation (the EU or US)? What is the 'correct' threshold level of *spurious emissions* and *human hazards*? RFT will expose the roots of the regulation to reach a more 'rational' allocation and standardisation.

Models are a simplification of a far more complex reality (Seedhouse 1997:43-4); RFT fits this definition. Models are giving or being given shape; the aim is that a theoretician's guesswork will ultimately reveal the true shape of reality. The key is to explore and define the *rational fields* which are operating; in so doing, this promotes real debate. This may be the primary ingredient of a sound approach to the management of *societal concerns* in regulating uncertain risks and innovatory RF allocations. It is intriguing to apply RFT to RF licensing and to gain benefit by modelling the issues in a coherent methodology.

RFT logically separates the decision processes into their classifications/ instincts/ strategies/ means/ goals, and elucidates decision-making factors. Philosophical aspects often guide decisions; RFT employs philosophy to shed light on the meaning of life. The RFT may contrast the 'centralization of technocratic authority over public value judgments' (Graham and Wiener 1995:242); 'solutions based on expertise and value choices are the likely avenues for improvement' (id.). Seedhouse (2002:36 figure 5) depicts mental health according to conventional and alternative speculations. The 'Health' grows from the absence of disease, to the absence of illness and to the statistical normality. A foundation theory of health can be adapted to other network services such as communications; e.g. 'healthy' RF systems suffer less *spurious emissions*.

The RFT templates assist to analyse the process of RF regulatory decisions. Figure 4-1 is the template to be used for the RF examples in the next chapter. The template sets out the rationale systematically, and thus allows testing of logic, coherence, likely benefit and likely cost (Seedhouse 2002:141). The *rational fields* are utilised to organise the rationale and understand certain definitive RF decisions. The template is aimed mainly at rationalising on a national level. In the next chapter, RFT templates contrast the US and EU RF *regulatory frameworks*, and explore two uncertain RF risks: *human hazards* and *spurious emissions*.

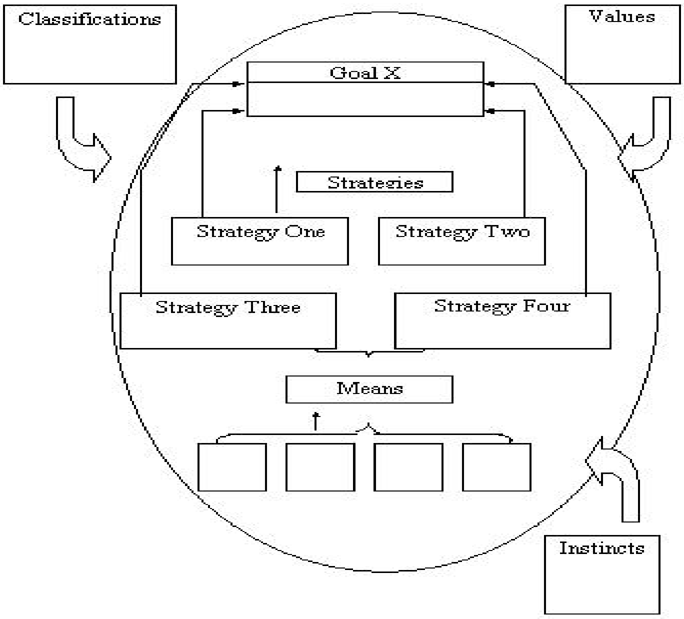

Figure 4-1 The rational field template[56]

Scarce resources allocation, standardisation and regulating uncertain risks are derived from the national regulation policy and deeper cultural sources. The RFT cases should be logical; the goals compatible and realistic, and the strategies and means appropriate to the achievement of the goals (based on Seedhouse 2002:116).

4.2 Criticism of RFT

Given that our rationality is bounded, the questions to be asked are as follows: are we really surrounded by a sea of *rational fields*? Are we rational at all? The success of RFT implies that the goals of decision-makers are known explicitly. When synthesising an agent, one can know or determine the goals of the agent, but when analysing the behaviour of policy makers, one does not know their goals; in fact, the range of rational goals can lead to such variant behaviour that assumptions about those goals cannot be made with confidence[57]. If

[56] Seedhouse 2002:66; thanks to Pr. Seedhouse for approving the use of the template.

[57] Based on Simon Herbert response to John R. Anderson (mentioned before).

we cannot analyse all the influencing elements, it might be better to renounce logic, and to leave decision-makers and regulators to create regulation according to their worldview, beliefs, conscience, knowledge and instincts. The *rational fields* try to avoid over-simplification; however, the fields are oversimplified. The 'shadowy pattern of truth' (Seedhouse 2002:143) is complex and may cover more than it discovers. In comparison to Cost-Benefit Analysis, RFT doesn't grade the alternatives; it is only qualitative.

4.3 RFT- Summary

The templates of rational fields expose the walls surrounding the regulated items, providing a broader view and other aspects to RF allocation and licensing; it is a philosophical tool to convince that there is more than one way of doing things. The RFT template links between means, strategies and goals. This method evaluates the goals and assesses the match between selected goals and the surrounding instincts, classifications and values.

Any assumption is relative, as there is no absolute truth; the template states the values and classifications, so they can be argued and contrasted; the *rational fields* lay out the contentious points so that they may be understood; a clear set of goals, strategies and means makes disputes transparent (Seedhouse 2002:143). The RFT plan maximises the opportunity for both consumers and regulators. Visually based, the theory includes (without distinction) engineering, economic, legal and philosophical aspects.

It is intriguing to apply RFT to scarce resources such RF, water and land allocation, to regulation of uncertain risks and to gain benefit by modelling the issues in a coherent methodology. RFT joins CT to explore RF rules and standards for the first time. The methods of RFT in promoting health serve as tools for the diagnosis of services of general economic interest, like wireless communications, and to analyse the health of wireless systems. Using RFT enables to include philosophical aspects, to expose in a transparent manner the values that guide decisions. It encourages public discussions and consultations on the values, classifications, instincts, means, strategies and most importantly the goals of a proposed regulation, allocation, licensing or standardisation. The debate will focus on uncovered arguments and *rational fields*. RFT may serve as a 'democratising' tool, because it enables those concerned to discuss the item and assign their own weighting to the criteria. RFT shows how various cultures and geographies lead to different values, and may result in an opposite RF ruling. RFT is the third sociological theory to offer an explanation of the pattern of RF licensing and standardisation, and issues of *societal and risk concerns*.

5 Three Synthesised Sociological Theories

Figure 4-2 integrates and synthesises the three theories of this research; the core represents the decision-maker's rationality. The empirical data shows how culture and geography influence; the social networks shape the decision-maker's rationality. The figure depicts the theoretical consistency in the thesis, the common points of the theories, and the main contribution of each theory to explain the empirical results (see next chapter). CT categorises the countries in terms of the perceptual CT filters, the BR investigates the apparent irrationalities, and the RFT shows how values guide administrations in their strategies.

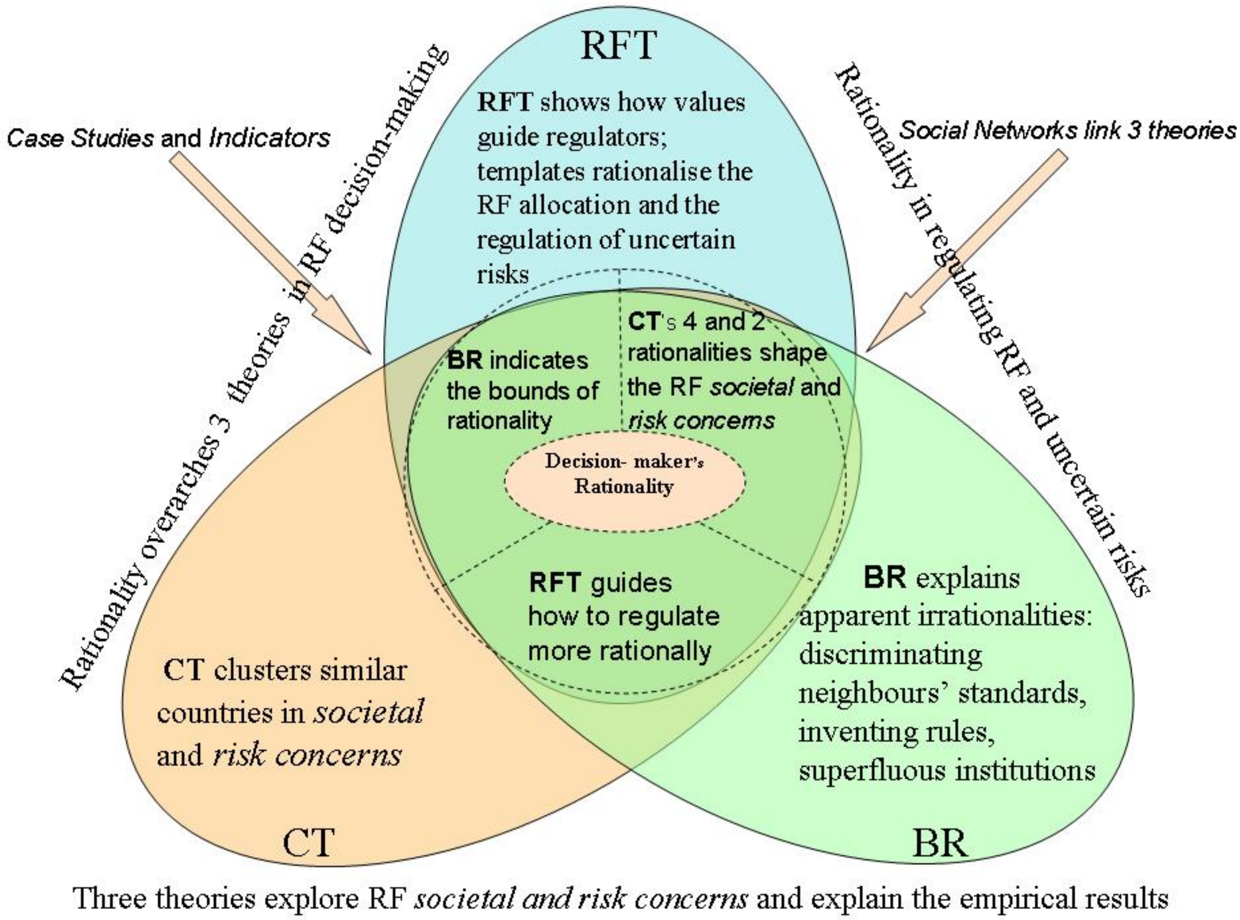

Figure 4-2 Three contending theories explore the results by the decision-makers' rationalities

The *collective values* and *social institutions* formulate the different rationalities. The worldview, values, beliefs, instincts and biases were discussed. The place of birth and the nuclear family link geography, language and religion; these are the attributes that bound the rationality of RF regulation and standard adoption. Naked objectivity is not enough to make good sense (Douglas and Wildavsky 1982:72). The experience challenges the very nature of knowledge and objectivity (Burgess 2004:150, citing Barbara Adam 1998 *Timescapes of Modernity*). There are many sociological perspectives on risk, of which *Cultural Theory* (CT) is but one that analyses risk in regulation. There is not one technical 'single best' theory on *societal and risk concerns*. CT is a model to be investigated as other models, like *Rational Field Theory* (RFT); both theories are used to analyse risks and RF hazards. The RF *human hazards* are examples of real or subjective phobia ('phantom risk'), which are understood only by an inter-disciplinary approach. As philosophical arguments, personal worldviews, ethics and values are important for the RF regulatory policy, they are included in the research through CT and RFT. *Bounded Rationality* (BR) is used to explain decisions that are not objectively rational.

Three different theories, which have been used in projects with some relation to the research, serve as the theoretical background of decision-making; CT, BR and RFT are applied to RF. CT provides four social bases of control serving as up-grid and up-group criteria to interpret regulatory style (Hood *et al.* 1999:197); CT will rationalise the empirical results and will categorise countries in terms of four perceptual filters (see next chapter, figure 2-1). Possible contrasting models of regulation analyse the two-dimensional (instead of four) model of *collectivised-hierarchy* versus *individualised-market* (next chapter, figure 2-2); the regulatory style will serve a criterion to categorise countries. CT will illuminate the wireless regulatory development, and explain the regulation of uncertain risks and technological innovation. BR fills the gap between the rational decisions and the actual decisions; it will explain the apparent irrational RF decisions, and why decision-makers do not act always rationally to achieve their goals. RFT organises the scarce resource allocation and regulation of uncertain risks logically, by paring the process down to its classifications, instincts, strategies, means and goals, and elucidating the decision-making factors. RFT rationalises the allocation, licensing and standardisation processes.

This thesis concerns the different rationalities of national decision-making under the conditions of risk and risky choice. Abstracted and generalised, the three theories serve as genuine explanatory tools for this behaviour. The three theories provide models of a simplified representation of a more complex reality, in order to reveal the true shape of reality; the theories develop a framework for explaining social responses to risk. A thin line links different rationalities and *risk tolerability*, in order to analyse the wireless *regulatory framework* and adoption of RF standards. Three theories apply a multiple-rationality approach in order to interpret the data and to explain the results for both the in-depth case-studies and broad brush studies; the synthesis of the theories will tie the results neatly and may generate a useful output.

6 Conclusion: Theories

Following deregulation and liberalisation also in developing countries, the RF allocation and the telecommunications market are not an act of regulation of a monopoly; it is more about allocating a scarce resource and a common good, standardisation, regulating a networked service of general economic interest and uncertain risks. This chapter looks at the methods of regulation, standardisation and of tolerating risk, in order to draw some initial conclusions on which countries/cultures are more likely to regulate in which way and why. RF regulation is about producing welfare and justice; we can learn from the ways different cultures tackle similar regulation, to see what models might be adaptable to explain the empirical results. The *central-planning* and *market-based* approaches are opposite ways of modelling resource allocation and risk acceptance. The way and style in which administrations regulate scarce resources and uncertain risks depends on common national worldviews, rationality, values, goals, politics and the policy of decision-makers. The main difference between regulators is their choice of either *collectivised central-planning* or *individualised market-based* solutions. The interaction of the individual with the state defines the framework of the regulation; national administrations have different interpretations of the ultimate benefit to their citizens. Market forces generally provide the right economic solutions, and assure the efficient distribution of resources via an 'invisible hand'. However, *central-planning* is essential to protect the (RF) environment and to grant assured resources to the broadcasting and emergency services (police, fire and medical personnel). Rooted in ancient Greece and Christianity, in the western world the citizen-consumer seems to be the ultimate reason for regulation.

The *social networks* reveal the sources of different rationalities; the *social order* establishes the deemed 'rational' way and may appoint *bounded rationality*. In the next chapter, the three synthesised sociological theories will examine the regulation (style and essence), and explain the differences in wireless rules, standards and regulating uncertain risks.

The attributes of culture, which characterise and may unify the state, are language, religion, legal origin, history, tradition, education, geography, sense of self and self-belonging. The chosen theories follow a principle of simplicity: they are simple and will provide rational explanations. Complex regulation, large scale allocation, licensing network projects or regulating uncertain risks require the qualitative techniques of CT, BR and RFT. The fundamentals of regulations are the same if we explore health, environmental or RF regulation. These utilities are an essential component of human happiness and safety. The analysis and regulation of the regulatory process is necessary and appropriate. The three theories include a discussion of how they might be used to perceive, examine, evaluate and explain the *Case Studies* and worldwide results.

The attitude towards allocation of scarce resources and regulating uncertain risks is derived from a social prism: risk perception, environment concerns and competition. The society's culture controls the regulatory frameworks; therefore CT, BR and RFT may explain RF allocation and licensing. The theories are interlinked; the *social networks* provide the *social*

context and associate the three theories, as does the plurality of rationalities. This chapter has explained why the three theories are useful in understanding the rationale of the regulation.
The empirical survey has shown that there are aspects of RF regulation and standardisation that are currently not correctly executed, or are even irrational; RF allocation and licensing does not always take into account *societal and risk concerns*. The CT awareness that we are different, our basic BR, and the philosophy of RFT provide the three dimensions for understanding how society functions and how decisions are made in RF allocation, regulating uncertain risks and standardisations.

Chapter 6 *Discussion: Three Theories Explaining the Empirical Results*

Contents

Figures

Preamble

The *International and Regional Regulatory Frameworks* chapter 2 (thereafter *International Frameworks*), *Case Studies* chapter 3 (*Case Studies*) and the worldwide *Indicators* chapter (*Indicators*) have explored 'how' culture and geography affect the wireless regulatory framework. These chapters reveal patterns that are rooted in culture and geography. After exploring 'how' countries regulate wireless uncertainties and adopt RF standards, this chapter explains 'why' culture and geography influence regulation. The findings are analysed in the light of the three theories used in this research. The chapter explains the role of language, religion, legal origin and geography in regulating RF uncertainties (*human hazards* and *spurious levels*), innovative regulation, the adoption of analogue TV (SECAM, PAL and NTSC), digital TV (mainly of EU and US) and digital cellular standards (of EU or US). The 'rational fields' will illustrate the risk concerns and why countries are influenced by either the European or the American wireless hemispheres.

The *Theories* chapter (thereafter *Theories*) explored the ideas that are relevant to the empirical findings in order to understand, analyse and draw conclusions about each particular approach to RF regulation. *Theories* explored the four-fold and two-fold prototypes of regulators (*Cultural Theory*), the *Bounded Rationality* of the decision-makers, and the values and goals in regulation (*Rational Field Theory*). The following sections analyse and explain the *societal concerns* and the regulation of uncertain risks. This *Discussion* chapter denotes the theoretical analysis of the case studies and worldwide standardisation.

RF *human hazards* are a risk to human health, while *spurious emissions* are a risk and threat to the RF systems' health; managing RF for innovation is uncertain and risky. The three chosen theories serve to explain the empirical findings. Not all three theories justify all the results of the preceding chapters, as some theories are not appropriate to explore certain sets of results; however, the same result may be analysed by two or three theories. An array of explanatory theories is proposed and will be examined. The emphasis of each theory is different. The theories reveal why culture, bounded rationality and worldviews create a framework for RF regulation and standards which is not always goal-oriented, and thus does not manage to achieve better wireless communications at lower prices.

1 Summary of Empirical Results

The exploration of Europe, EU, South America, *CAN* (*Comunidad Andina de Naciones*), UK, France, USA and Ecuador permits us to understand their wireless *regulatory framework*. The *International Frameworks, Case Studies* and *Indicators* show that choices are bound by culture and geography. The main difference in wireless ruling lies between developed countries and the developing world. It may be seen that developed countries regulate their RF in a similar way: transparently, flexibly, market oriented, with minimal non-tariff barriers, promoting new technologies, trusting their clients (the citizens), serving the 'citizen consumer' and the end-users (this at least the claims made, which are not always true). The *International Frameworks* and *Case Studies* indicated the significant differences between Europe and the US in top-down mandated standards, permitted RF *spurious emissions*, permitted RF *human hazards*, allocation of RF spectrum to Licence Exempt devices and type approval process. As developing countries make up most of the world's population, it is important to study how they allocate and license the RF spectrum; the research on Ecuador, *CAN* and South America depicts their wireless *regulatory framework* and reveals the status of 'tropical developing' nations.

The CEPT regulation and ETSI standards are fundamental in Europe, Africa, Arab countries and most of West Asia; whereas, FCC standards are applied in the Americas and certain countries in Asia and Africa. Due to the twofold classification agreed upon in the

International Telecommunications Union (ITU) Cairo 1938 Conference and dissimilar allocations introduced in Europe and America (deriving from the different preferences on either side of the Atlantic), today the digital Cellular standards (European UMTS and American CDMA2000) operate in different RF bands; moreover, ITU Region 1 (and Region 3) countries that use 7 or 8 MHz channels are discouraged from adopting the American ATSC and the Japanese ISDB 6 MHz channel standards, because equipment is not available that would make full use of their 7 or 8 MHz channels. In the 21st century countries in Europe and South America have reduced their national RF allocation and standardisation activities, and now pool some of their sovereignty and decision-making powers to create regional markets and agencies, such as EU and *CAN*. The European RF harmonisation is unique; all other continents did not harmonise their RF allocation, broadcasting (sound and video) allotment, licensing and standardisation like Europe. UK, France, USA and Ecuador offer valuable theoretical contrasts in their regulatory styles. A parallelogram of rationalities can be traced: the *collectivised* approach of France and Ecuador versus the *individualised* style of UK and USA. The UK Ofcom's motivation is mainly economic; engineering considerations are more dominant for the French ANFR; for the US FCC legal factors appear paramount; Ecuador characterises tropical countries in its collectivised wireless regulatory framework and development status.

The homeland security needs of the US, France and UK affect the global RF allocation. These three ex-imperial countries have a long history of worldwide influence. The colonial inheritance of the UK and France is reflected in the wireless standards around the world. Generally ex-colonies tend to preserve the culture bestowed upon them; the inheritance of the past may influence the present national *regulatory framework* of communications. The ex-colonies probably follow the geopolitical influence, RF rules and standards of the colonisers that once ruled them. In general, English-speaking countries are Protestant and follow the *common law*; French and Spanish-speaking countries are Catholic and apply the *civil law*. The statistics depict a strong correlation between cultural factors and RF regulation; therefore we may conclude that decision-makers of the same heritage may adopt the same RF standards, and share a similar perception to risk and attitude to market. The illustrative figures depict the geographical and cultural links to RF standards, emphasising the anomalous countries, relative to their neighbours.

Each particular continent defines its own regional RF allocation; the distance from the Equator affects its development and cellular penetration; level of penetration increases with the distance from the Equator, that is, cellular penetration is higher in the northern countries of the northern hemisphere and southern countries of the southern hemisphere. Wireless rules are a useful indicator: TV and cellular standards and RF thresholds (*human hazards* and *spurious emissions*) reveal the cultural and geographical roots for each country. Post-colonialism, the ITU separation to three regions and recent attempts to resist the US hegemony all influence the current RF allocation and licensing. Cultural elements and politics define the RF *regulatory framework*, *societal and risk concerns*. Geography, culture, and decision-makers' rationality are strongly linked to RF regulation and standards, being factors alongside geo-politics and state politics. The wireless regulation and adoption of standards reflect each country's regime and its attitude towards the *market-based* approach.

The main empirical results revealed that in general, geography does indeed shape the wireless standards; there exists a wireless tropical underdevelopment. The cellular penetration in Europe is higher in Protestant and Catholic countries. French-speaking countries have adopted the SECAM colour TV standard, further demonstrating the influence of colonialism. Geo-policy influences the adoption of wireless standards: countries influenced by the US operate the analogue TV standard NTSC and the digital TV ATSC. Countries influenced by the UK and Germany operate the analogue TV system PAL; the European influence is revealed by the adoption of the digital TV standard, DVB-T. This European influence similarly guides countries toward the digital WCDMA cellular UMTS, whereas the American influence leads to the choice of CDMA2000. The cellular penetration in the US and Canada is relatively low. Practically all countries operating cellular use GSM, except Japan. Japan is unique in language, religion, and in its RF *regulatory framework* covering exceptional allocations and exclusive standards. The US, Canada and Japan are more tolerant of RF risks: *human hazards* and *spurious emissions*. The ‘allied’ countries - Australia, Canada, New Zealand, UK and US - manage the RF innovatively. None of the innovative or tolerant countries is tropical. Switzerland and Italy are the least tolerant of *human hazards* from EMF (Electromagnetic Fields and Magnetic Fields) risks. It may be said that countries applying *the civil law* are more formalistic than *common law* countries.

The *International Frameworks* and *Case Studies* highlighted the fundamental 'irrationality' in RF regulation: unnecessary regulation and institutions that restrain the introduction of new technologies, instead of following regional rules and adopting existing standards. The findings provide data emphasising the *Bounded Rationality* of decision-makers. If SECAM was voted the technical TV standard (preferred by 25 out of 27 French-speaking countries), then why did no Spanish-speaking country (a total of 21 states) adopt it? If the Japanese digital TV (ISDB-T) was rated technically best by Brazil in 2004, why then did South Korea (Japan’s neighbour) not adopt it? If CDMA2000 was a better technology for 3G than UMTS (at least more mature and with less power emissions), then why do Europe and most of the world prefer the UMTS technology? Why did Japan develop its unique regulation during the 20th century, which prohibited (at least through the exclusion of RF incompatibility) the export of their cellular successful (technologically) systems PDC and PHS? If the ‘allied’ innovative policy toward uncertainties is correct, then why do other countries not manage RF in the same way? Why do Switzerland and Italy adopt ultra-low permitted emission levels for cellular towers and electricity (1% of ICNIRP -International Commission on Non-Ionizing Radiation Protection- level), whereas for other citizens (with the equal human vulnerability) the factor is 4/3 (of ICNIRP level) in Canada, Japan and USA?

The *Indicators'* statistics pointed out certain extreme results that appear 'irrational'[1]. In addition to the decisions of Switzerland and Italy to extremely reduce EMF thresholds, it may be stated that *Bounded Rationality* caused:

- Algeria to choose PAL, while other Maghreb countries chose the French SECAM standard;
- South Korea to prefer the US digital TV ATSC over the Japanese ISDB system, and the US digital cellular CDMA over the Japanese PDC technology;
- South American countries insist on their independent RF *regulatory framework*, their superfluous institutions and standardisation institutes.

The multiple *Case Studies* and empirical data depict that in general the basic policies of RF allocation, licensing and *risk tolerability* do not change. The differences can be attributed to the various cultures and national 'behavioural specificity' (Barsky *et al.* 1997:550); countries do not frequently change their cultural fundamentals and *collective values*. Globalisation and regional RF rules, in addition to industry traditions in standardisation, have reduced the impact of national regulation. Culture and geography set the general patterns of regulatory behaviour; they can explain differences in RF regulation and *risk tolerability* among countries: between developed versus poor countries, *individualist* Western versus *collectivised* East Asian clusters, and tropical versus non-tropical climates.

2 *Cultural Theory* Categorises Countries in Terms of Perceptual Filters

2.1 The Four Cultural Rationalities and Regulating Uncertain Risks

The *Cultural Theory* (CT) prototypes usually illustrate the perception of risk toward nature, namely, the ‘myth of nature’ (Schwarz and Thompson 1990). Armed with this model, instead of exemplifying the tolerability of nature to risks (such as climate changes), the ball in our case depicts the conception of human health, and the tolerability of our body, using

[1] As the definition of irrational is not clear, thereafter ‘irrational’ is with quotation marks.

the same four prototypes. CT provides the up-grid and up-group criteria (collectivism versus egalitarianism) to interpret the empirical data; the degree to which one social group stands out from another shapes the formal public management oversight and control (Hood *et al.* 1999:14), typifies the society and is revealed in its *regulatory framework*; therefore CT may classify and categorise national attitude toward EMF, based on the four prototypes mapped out by Adams and Thompson (2002:8-9). The prototypes represent the tolerability to risk of national administrations, as demonstrated in the cross-national study of *human hazards* thresholds, in the *Indicators* chapter. The typical countries for each perceptual filter (e.g. the *egalitarian* is the most stringent, and the *individualist* is the most tolerant in EMF from cellular stations and from powerlines) are specified in Figure 2-1. The national adopted EMF levels, hierarchism and hazards perceptions (risk averse or risk seeking) serve as criteria to categorise the countries by four prototypes. Figure 2-1 classifies the attitudes of countries toward RF *human hazards* using the four CT rationalities. The *Rational Field Theory* explores the same results (see Figure 4-2).

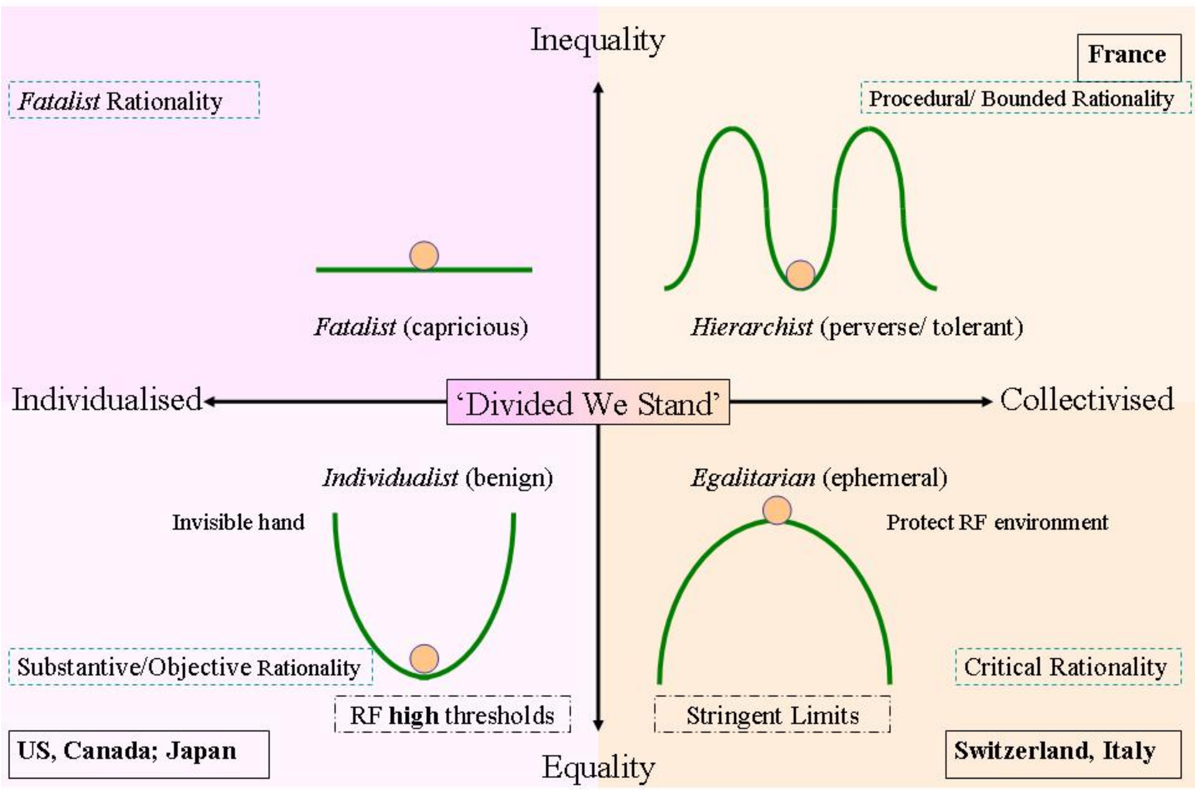

Figure 2-1 Four perceptual filters categorise countries by their *human hazards*' thresholds

– The *egalitarian* fights for the future of the planet, organises anti-EMF campaigns, elevates routine incidents into crises, acts as an amplification station, undergoes alienation from the government, electric and cellular carriers. He/she represents those who find that, unbeknown to them, a wireless operator has erected an antenna tower in front of their window. The *egalitarian* believes that all social primary goods and risks are to be distributed equally; the optimal solution is to spread many small cellular antennas uniformly, instead of less base-stations; and in this way to apply equal risk to all. His/ her worldview is that there exists no 'one ultimate vision'; this is in line with the emancipated and democratic risk analysis (Kasperson and Kasperson 2001:501). The countries (such as Belgium, Bulgaria, China, Greece, Luxembourg, Israel, Italy, Poland, Russia and Switzerland) that reduce the international level of EMF are less tolerable to risk; for them the EMF lies in the 'unacceptable region' (see Tolerability of Risk, in the *Literature Review*, subsection 2.4.2). *Human hazards* are considered 'guilty until proven innocent': the ICNIRP levels are dangerous until proven otherwise; regulators should assume the worst-case scenarios and to act accordingly: to reduce the ICNIRP thresholds. Switzerland and Italy are specified in Figure 2-1, as they are the most stringent in EMF from cellular stations and from powerlines; they are the most precautionary.

─ The *hierarchist* view is typical of the civil servant; his/her role is to represent the public and the community, in order to achieve better wireless communications and electricity services, without neglecting *societal and risk concerns*. He/she trusts the institutions and authorities in order to bridge the confidence gap. This behaviour characterises most people, societies and countries that follow the international levels without alterations. For the *hierarchist* EMF is tolerable, after all, since practical means were applied to reduce the EMF. Excessive reduction would surpass any improvement gained. France is specified in Figure 2-1, as France is typical to countries adopting the ICNIRP levels in EMF (both Electric and Magnetic fields). Even though France seeks out equality (*Liberté,* ***Egalité****, Fraternité*), the collectivised *regulatory framework* of France fits the *hierarchist*: a large number of officials in ANFR, 'command and control' style, top-down governance, characterised by universalism.

─ The *individualist* is a risk-seeker; he/she knows that the benefits of the cellular technology and electricity are real. These are the countries whose thresholds, for cellular stations, reported to the World Health Organization (WHO) are higher (more tolerable to risk) than the international levels: Canada, Japan and USA; therefore they are specified in Figure 2-1. These countries are risk prone; they promote efficiency, growth and progress. For Canada, Japan and USA, the EMF lies in the broadly acceptable region; there is no need for detailed working to demonstrate ALARP (As Low As Reasonably Practicable). The EMF risk is tolerable. It is necessary to maintain an assurance that the risk remains at the present level, without injuring electricity and cellular industries that improve our lives and create jobs. The *individualist* tends to put individual before collective benefit. *Human hazards* at ICNIRP levels are 'innocent until proven guilty': they are not dangerous until proven scientifically to be so; EMF is a 'phantom risk'.

— *Fatalist* behaviour characterises the persons and societies that are actively disinterested in and do not consider the possibility of harm from cellular phones and power-lines. The *Case Studies* and *Indicators* chapters could not indicate even one country indifferent to EMF hazards, which is regulated in the *fatalist* way, 'by chaos, as a gaming machine' (Hood 1998 165-7). Nevertheless, *Indicators* pointed out that the vast majority (in general poor countries) seem to be not very alert to the dangers posed by technology. *CAN* countries, not informing WHO their EMF exposure limits, apply an EMF ruling; e.g. Ecuador follows ICNIRP levels (see *Resolucion* 01-01-CONATEL-2005); therefore no country is specified in Figure 2-1.

It is important to emphasise that the categorisation is not distinct, strict, stable and stereotyped into a particular prototype. All four cultural types can be said to exist in each administration and in each national institution. Countries are *egalitarian* about issues that are very important to them, such as GPS for the US; therefore, the US requests more protection: i.e. more restrictions on *spurious emissions* in the GPS band. Switzerland and Italy are *egalitarian* on *human hazards* from cellular base stations, but they are *individualist* (relative to the US) in cellular handsets with SAR (Specific Absorption Rate) higher than the US threshold. Administrations are *hierarchist* about most matters, for example, the European Community recommends (EC General Council REC 1999/519) to follow the international thresholds for *human hazards*. Administrations are *individualist* about items that they think are well managed (e.g. *human hazards* in Canada, Japan and the US). Decision-makers are *fatalist* about most things that really do not interest them and in which they do not have time to get involved; they are sceptical and unwilling to plan ahead or to take drastic measures; this includes *spurious emissions* in poor countries. It should be noted that, given the circumstances, the attitude of poor countries toward some uncertain risks is rational; the rationality is bounded in the attitude of rich countries toward risks, such as *human hazards;* for example Italy and Switzerland, with their ultra-low *human hazards* threshold.

2.2 *Societal* and *Risk Concerns* to Explain the Findings

Voluntary Risks versus Involuntary Risk

The RF hazards of cellular towers and power-lines illustrate the voluntary versus involuntary risks: while using a cell phone and electricity are assumed to be one's personal responsibility and a voluntary act, exposure from emitting towers and power-lines are not. Chauncey Starr (1969:1232-8) proposed three tentative laws providing a quantitative instrument; see *Literature Review*, subsection 2.3.1. The first law (the public is willing to accept voluntary risks) explains that the persons fighting against the cellular towers do nevertheless use cellular phones; since individuals are freely allowed to incur danger that threatens only themselves. The second law (the acceptability of risks appears to be roughly proportional to the real and perceived benefits) probably explains the positive perception of cellular activity in the Scandinavian countries (benefits to industry). The third law (the acceptable level of risk is inversely related to the number of persons exposed to that risk) emphasises administrations' concern, regarding more than 3 billion users of cellular phones and millions of base-stations worldwide.

Geographical and Social Amplification

Literature Review figure 2-1 'Ripple effects amplifying the risk' depicts the *social amplification* of *human hazards* fears, due to the erection of broadcasting station, cellular mast and electrical pylons; the figure is typical to developed countries. The press and media play an important role in *social amplification* and 'social construction'; issues coming to the public attention are not always those with the highest objective risk, but those often driven by the media, to which authorities feel disposed to respond. The US is different from Europe in this: the US is a large, diffuse society, with the absence of a widely read national press and regional power distribution. This difference is another explanation for the more restricted values of *human hazards* in Europe contrary to the US. Speaking the same language plays an important role in spreading fears about *human hazards* and amplifying risk. A common language eases communication and interconnection, as in the case of low thresholds in Italy and Switzerland, where *social amplification* transferred fears to Switzerland through the Italian language. However, different languages create barriers to adopting others' rules.

Italy also influences Slovenia (not in Italian language), through geographical proximity; the three countries are the states where EMF precautionary guidelines are mandatory. The *Indicators* demonstrated another 'geographical amplification': vicinity influences the adoption of wireless standards; neighbour countries adapt their standards to their neighbours, in order to reduce interference, and to enable reception of neighbours' broadcasting signals.

Zero Risk and Risk-versus-Risk in Regulating Uncertain Risks

The wireless risk and innovative regulation are related to 'risk-versus-risk'. Restricting *spurious emissions* prevents the penetration of competitive lower-priced equipment; reducing the RF power and the bandwidth of Short Range Devices or Ultra Wide Band precludes the entry of new technology; avoiding the application of Software Defined Radios or RF trading results in a non-optimal use of the RF spectrum. The risk in adopting regional harmonisation is contrasted with the harm caused to the independence of decision-making, and to the optimisation of the RF spectrum to local needs[2].

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[2] See Recommendations 4.1 to 4.5 Martin Cave Report (2002:35) about the risks of harmonisation.

The corresponding and conflicting consequence of risk-versus-risk (and also its 'shadow') is benefit-versus-benefit. More RF resources available to the citizen, and more RF power and bandwidth for Short Range Devices advance the rapid growth of new technologies and services (such as Wi-Fi and broadband access). This benefit can be compared to the opposite benefit of better quality of service (less congestion, if less citizens use Short Range Devices-SRD) and less ‘tragedy of commons’ in the RF ‘public park’.

The stable 'Pareto optimal' (Simon 1985:296) and the democratic stance of the decision-maker may maximise the benefit to the citizen and the wireless consumer. How important is it to endorse new technologies with the consequence of some interference to existing licensed services? Should the regulator avoid the ‘tragedy of common’, by preventing any new unlicensed users, or limiting the RF power/bandwidth? The RF regulator and *Rational Field Theory* tackle these 'moral' questions.

The Uniqueness of Japan in Wireless Regulation

Japan employs stringent administrative *central-planning* like France (and Germany); but, at the same time permits high *spurious emissions* and high *human hazards* levels as in the US and Canada. Japan implements individualism in its regulatory style, while Japanese society is paternal and devoid of ego. Faraway from Europe and the US, Japan is a group of vertically aligned isolated islands and a homogenous society[3]; a hierarchical society with importance of duty and honour; obedience, trust/ distrust, respect and loyalty are entrenched at home. The Emperor symbolises the State, the unity of the people and represents the “collective command and control” over Japanese society. The *egalitarian* view noted by Hood (1998:143), which is characterised by solidarity and managing without managers (super-highways, mass participation), fits Japan. Douglas and Wildavsky (1982:90) portray Japan (and Taiwan) when describing Collectivisation: “the responsibility is done by making roles anonymous; decision-making is so *collectivised* that no one is seen to decide; all operate on fixed instructions, everyone executes and no one decides policies”. Japan believes in the concept of Harmony (*wa*). However, Japan behaves also in a lonely ‘Samurai’ individualistic manner; the Shinto religion sanctifies the productivity of man; similar to Calvinistic predestination, Shinto believes that the fate of an individual is predetermined by god, success indicates the blessing of god *Shushigaku*; (compare to Weber 1904-5:102,271). So the trust in the administration and the 'Samurai' ideology could guide Japan toward risk-seeking rationality; the distrust toward strangers ('*tanin*' or '*yosono hito*'), the geographical and linguistic barriers could cause a unique regulation, where the wireless industry favours

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[3] In language, religion, ethnicity, history, tradition, education, philosophy, ideology, goals, values, beliefs, preferences, obedience, way of thinking about life and sense of belonging.

the internal market.

2.3 Summary: Four Cultural Prototypes and RF Uncertain Risks

Cultural Theory is a pertinent theory to explain the *societal and risk concerns* in regulating the uncertain risks EMF and *spurious emissions* (see also subsection 2.4.2). The four protagonists of the *Cultural Theory* typify the different state regulators and the main actors in the origin of RF *human hazards* from cellular base-stations and electric lines. CT interprets systematically the empirical data and categorises the countries by perceptual filters. Schematically, the *egalitarian* represents the groups directly touched by the effects of EMF; for *egalitarian* countries (such as Switzerland and Italy) human health is a supreme value. The human body and wireless systems are 'ephemeral' and should be totally protected. The *hierarchist* is cautious; representing government agencies, he/she tries to reflect all views and to implement the political objectives and biases; the human body and wireless systems are 'tolerant'. *Hierarchist* administrations (most of the developed countries in the world; France is typical) consider EMF risks and *spurious emissions*, and follow the international (ICNIRP) level and the regional spurious thresholds. The *individualists* are the entrepreneurs: cellular and electricity carriers, and wireless vendors; for them, cost is also a *societal concern*; *laissez-faire* is the correct worldview to promote business. For the *individualists*, the human body and wireless systems are 'benign' and adaptable to *human hazards* or RF interference. Countries like the US, Canada and Japan support industry and such business-oriented values. The *fatalist* is the absent voice, the unworried citizen, consuming wireless and electricity services without a (hazard) care; for the *fatalist* the human body and wireless systems are 'capricious'. The *Indicators* chapter demonstrated that most poor countries do not regulate RF uncertainties, but they are worried about EMF. The risks, evidence, perception, precaution, public feelings and necessary actions of the various four protagonists (individuals and countries) are derived from different worldviews.

Voluntary versus un-voluntary, risk-versus-risk and construction of risk apply also in the *human hazards* case. *Social amplification* is probably one of the reasons why EU *human hazards* are more restricted than those of the US (the absence of a widely-read national press in the US), and that Switzerland and Slovenia followed Italy in implementing low thresholds. Risk-versus-risk and benefit-versus-benefit should be contrasted in regulating uncertain risks and in adopting innovative wireless rules. *Cultural Theory* explains the *societal concerns* of different countries to RF risks: the schematic model is a convenient simplification. Ideology, policy, values, equality/ inequality, and the *collectivised/ individualised* approaches illuminate and predict the institutional responses.

In RF spectrum policy 'one size does not fit all' (FCC 2002:5,36); *Divided we Stand* (the title of Schwarz and Thompson 1990 work): individuals, regulators and decision-makers are different. Countries regulate differently as their decision-makers are biased and prejudiced; they follow the traditional way of doing things, this innate behaviour brought them to their present position. Decision-makers are part of and reflect their national cultural climate.

Japan applies a collective *central-planning*, rooted in a hierarchical obedient society; but their regulation of RF uncertain risks is 'benign'; its tradition and religion may explain the tolerant standards in *human hazards* and *spurious emissions*. The uniqueness in RF regulation is explained by its geographical and cultural isolation: suspicion of outsiders and the e-Communications (and RF spectrum) in the hands of the Ministry of **Internal** affairs.

2.4 Four Cultural Prototypes Merged to Two Rationalities

The four myths of nature and the human body in the *Cultural Theory* bring us actually to 'plural rationality', instead of a single rationality. Combining the four prototypes into two, *collectivised* and *individualised* rationalities, introduces the *central-planning* versus *individual-market* approach. The *Case Studies* and *Indicators* showed that most countries implement polarised approaches to public affairs: state versus market, centralisation versus decentralisation, standardisation versus flexibility and ‘command and control’ versus choice. These national policies can be rooted in geographical location, religion, language, legal origin and geopolitical influence. Culture and geography form the *collectivised* or *individualised* attitude taken by each country. *Case Studies* and *Indicators* demonstrated a correlation between the adoption of RF standards and geography, language and legislative system, but not a strong correlation with religion. It was pointed out that the same cluster of *individualised* countries is relatively tolerant of risks, and at the same time manages RF for innovation (Australia, Canada, New Zealand, UK and USA); whereas, other *collectivised* countries (such as France and Ecuador) are more hierarchical. The *collective values* and 'behavioural specificity' may explain why the same countries show similar responses to completely different RF risky situations (permitted EMF from cellular base stations and electric lines, and permitted *spurious emissions*). The national risk tolerance is also a significant explanatory variable for innovative regulation.

The four prototypes may be integrated into two classifications. For this research the most distinctive wireless subjects were chosen in order to highlight the poles-apart *regulatory frameworks*, *societal and risk concerns*. The *central-planning* and *market-based* styles will explain the differences among countries in regulating uncertain risks and managing RF for innovation: *spurious emissions* levels, harmonisation, RF secondary trading, deploying UWB (Ultra Wide Band devices) and Software Defined Radios.

2.4.1 *The Collectivised* versus *Individualised* Types Categorising Countries

The *collectivised central-planning* versus *individualised market-based* types of regulation may explain and categorise countries. Figure 2-2 illustrates how the *central-planning* and *market-based* approaches explain the attitudes of states and the empirical results. The right side of the figure depicts the *collectivised* rationality and the *central-planning* countries. France and Ecuador (they are specified in *Theories* Table 2-2 and in the right side of Figure 2-2) typify the Catholic, *civil law* countries speaking French and Spanish; their *regulatory framework* reflects a paternal 'command and control', their *societal concerns* look for social justice and harmonisation; their broadcasting (content and infrastructure is regulated by a separate institution, CSA and CONARTEL); the regulation is driven mainly by engineers; they are cautious; France lead the RF harmonisation in Europe and directed the restriction on *spurious emissions*. In *Theories* Table 2-3 and the opposite side of Figure 2-2 refer to the five allied countries (Australia, Canada, New Zealand, UK and USA); they are Protestant, apply the *common law* and speak English; their *regulatory framework* exposes individualism, their *societal concerns* promote change and innovation and they are risk prone. In countries with a shorter history such as Australia, Canada, New Zealand and the US (the UK is an exception), these elements are deeply rooted: 'the importance of individual initiative, the fear of public authority, the value of increased political competition, the fascination with law and legal procedures' (Douglas and Wildavsky 1982:153); similar national behaviour characterises a nominal or high level of EMF exposure and managing RF for innovation. This in contrast to collectivised countries preferring low *spurious emissions*; their cellular networks envisage top-down technology (such as GSM) and an imposed Quality of Service, versus the bottom-up and unlicensed services (such as Wi-Fi). The 'light-touch' approach characterises the *market-based* style of regulation: this efficiency might be rooted in the *common law* (Djankov *et al.* 2003:35). An innovative regime favours the individual, while a collective worldview may favour well-resourced service providers, such as telecom incumbents.

Tables 6-2 and 6.-3 in *Case Studies* and Tables 2-2 and 2-3 in *Theories* compare and contrast the *collectivised central-planning* with *individualised market-based* rationalities; these tables may explain the empirical results; they are used to categorise countries: which countries are restrictive or liberal. As in the tables, the positive arguments are in the main focus of the forthcoming exploration; negative points are excluded, to save place (they appear as the advantage of the reverse rationality).

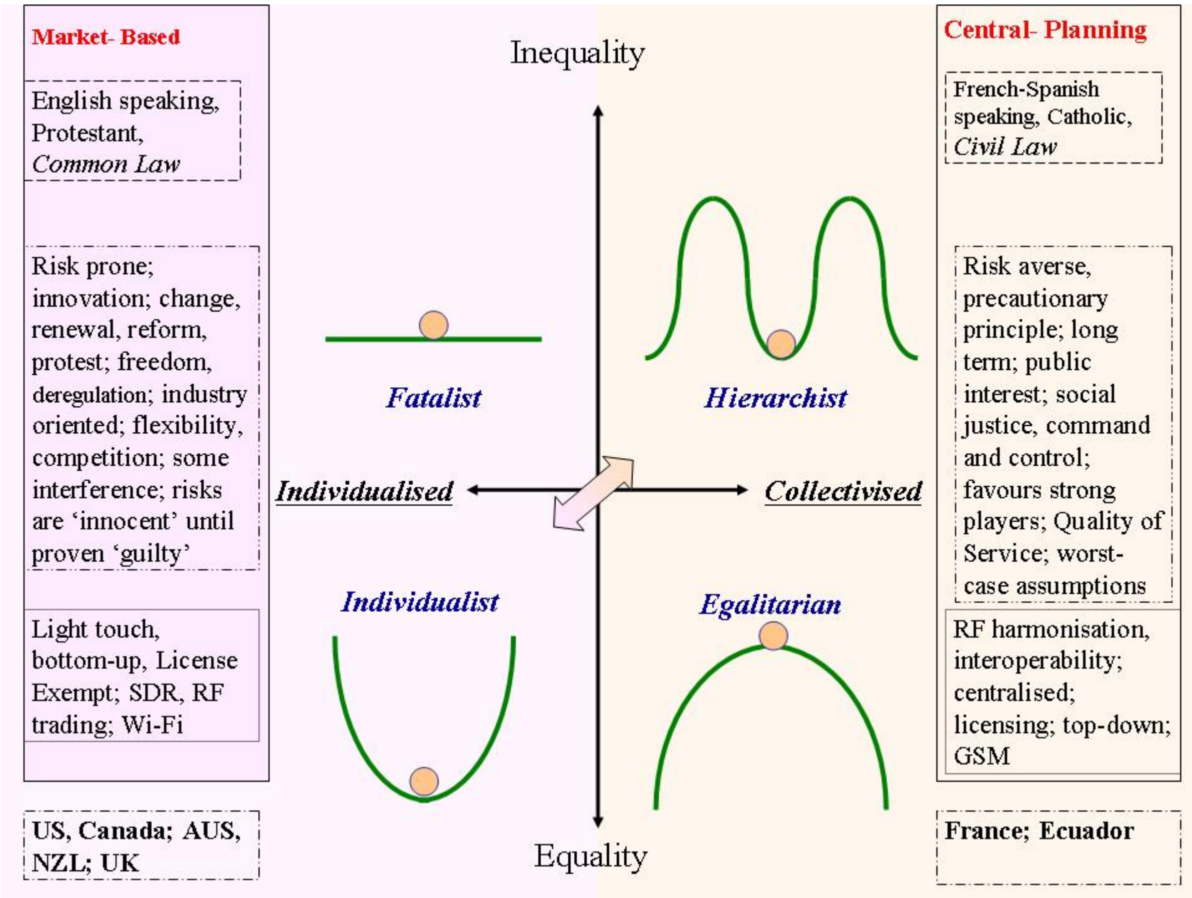

Figure 2-2 Two perceptual filters categorise *central-planning* and *market-based* rationalities

The following analysis might differ between developed and developing countries; developed countries have different needs. Rich countries are more concerned with any potential negative effects and thus regulate cautiously uncertain risks. Due to the low expenses on health, cultural, political and institutional factors, there are different risk patterns and risk perception in poor countries (Kasperson and Kasperson 2001:170). Countries in the western hemisphere are 'worried stiff about dangers from technology' (Douglas and Wildavsky 1982:123,127,137); while very poor countries, as a result of not knowing where their next meal will come from, acquire the habit of living in the present, and do not imagine the future at all (Douglas and Wildavsky 1982:74).

Moreover, *Indicators* pointed out that in general the poor countries implement the regulation, rules and standards developed by the rich countries. The two other theories include a discussion as to why this regulation is not followed more faithfully.

Figure 2-2 (in this chapter) and Tables 2-2 and 2-3 in *Theories* group the countries together to explain firstly the *collectivised central- planning* rationality: countries that restrict *spurious emissions*, seek harmonisation and top-down technology; secondly, the opposing, *individualised market-based* rationality in countries that permit high levels of EMF, *spurious emissions* and foster wireless innovation.

It is important to note that overall, there are more similarities than differences between the two rationalities of developed countries; *central-planning* French employs *market-based* wireless communications; however, the French style is more *collectivised* than the UK or the US *individualised* approach. The main differences in wireless regulation are between rich and poor countries. Rich countries concur in their attitude toward the wireless industry (vendors and service providers), citizen-consumer and transparency. We may denote the *regulatory framework* of developed countries as the triumph of the Individual over the Collective, even if developed countries like France are *collectivised*. Decision-makers of most developed countries (*collectivised* or *individualised*) serve the citizen-consumer as their ultimate client; regulators of undeveloped countries may serve other utilities and aims. The *regulatory framework* for wireless communications of developed countries is similar; however, their *societal and risk concerns* are different; the *risk tolerability* of poor countries is alike, they are less concerned and they adopt the EMF exposure limits of ICNIRP.

2.4.2 *The Collectivised* View explaining Restrictive *Spurious Emissions* and RF Harmonisation

European countries represent, in Table 2-2 in *Theories*, the CT *collectivised central-planning* rulers, enforcing lower (more restricted) *spurious emissions*, harmonising RF, and mandating technology (such as GSM and IMT-2000). This is in contrast to the US, Canada and Japan with higher permitted levels of *spurious emissions* (and *human hazards*[4]); see Table 2-3 in *Theories*. The roots of this diversity are explained by two opposing rationalities. Those are the characteristics of the *collectivised* rationality:

Ideology: ‘power in the hands not of a minority but of the greatest number’[5]. It is in the interest of the majority and group welfare to reduce *spurious emissions* (and *human hazards)*. RF is a common good; the 'tragedy of commons' occurs if all users, on an equal basis, cannot use RF. ‘Egalitarianism’, the *common understanding* of Kropotkin (1899), the *collective unconscious* of Carl Jung and the 'collective utilitarianism' all state that RF *spurious emissions* are bad; the *collectivised* interest aspires for ecological correctness and an environment unpolluted by RF (and lower *human hazards*); the environmentalists preach about nature conservation, and that one should consume enough only to satisfy a basic need (minimal *spurious emissions*). High levels of *spurious emissions* also cause interference to licensed services, including jeopardising lives. The regulator should intervene to protect the innocent RF user from cheap and polluting equipment. The RF usage should be centrally

[4] The same countries are the most tolerant in both RF risks: EMF and *spurious emissions*.

[5] Thucydide is cited under the title in the preamble of the ‘Draft Treaty establishing a Constitution for Europe’.

designed like a cathedral[6,7]; there is no design without a designer[8]. *Harmony of interests* (Adam Smith 1776:678) and harmonisation are essential to ensure the correct use of RF.

Regulation: RF spectrum is a scarce resource. Lower spuriousness causes less interference to RF receivers. The regulator knows the best solution, so it intervenes to protect the citizen. The regulator as patriarchal patron tells the citizen and the main actors of the wireless arena what to buy, what technology to use and what is good for society. The regulator ensures equal communications. The national administration should monitor the emissions, in order to abolish equipment that causes interference. Wireless devices should be optimised for conserving spectrum rather than cost. Top-down imposed technology is the main reason for the success of GSM; this could be repeated in the case of DVB-T, and in RF harmonisation, to achieve better interoperability.

Worldviews: Equity and equality are essential to protect the poor and the weak. RF priorities are health and public safety; RF may reduce the digital gap between poor and rich; culture, social benefit and human values are important. The engineer's worldview (in contrast to that of the economist) is that RF should be protected, in a similar way that wide guard-bands and hard shoulders at the side of the road are essential safety measures. Catholicism (as opposed to Protestantism) favours solidarity, collective action, welfarism, universalism (Catholice' in Latin is 'Universalism') and patronage.

Regulating Uncertain Risks: Lowering the levels of *spurious emissions* is risk-averse, conservative and contributes to stability. The long-term *egalitarian* view and the 'Precautionary Principle' oblige us to protect the RF spectrum; 'polite behaviour' (Raja and Bar 2003:10) and good enforcement are not enough. More *ex-ante* licences are needed. It is difficult to control the spread of RF equipment (especially Short Range Devices, SRD); therefore, for the long-term and future generations, RF must be preserved: minimum RF power and RF bandwidth should be given to the spectrum citizen-commons (SRD), and approvals should be limited for short periods of time. The wireless licenses will detail the restrictions on RF *spurious emissions*. A nature-oriented society takes no risks with the unknown effects of *spurious emissions*; RF interference (and *human hazards*) should be treated based on the worst-case scenario. High levels of *spurious emissions* are 'guilty until proven innocent': they are harmful until proven otherwise.

Network Services: Licenses should be specific; they were restricted to specific technologies and standards. Standards belong to the community and serve as their 'rallying flags';

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6 Raymond 2000: the Microsoft Cathedral (careful crafting) versus the Linux Bazaar (open-source).

7 'The history of France has been a history of '*nouvelles cathédrales*' (Vichney N. *Les nouvelles cathedrals,* 1974:1,11), cited in Crane 1979:39. SECAM and Minitel are examples.

8 Simon 1981/1996:34, citing Christian fundamentalists responding to Darwin.

suppliers contribute their patents and Intellectual Property Rights to the public standard on 'fair and reasonable' terms; independent developers hold an equal position. Standards should be developed through cooperation between countries. The GSM standard belongs to the collective: an open industry, open architecture and open subsystems interfaces; thus in contrast to the CDMA proprietary technology, where royalties are paid to Qualcomm for every CDMA handset sold. The detailed GSM standard enables an appropriate interoperability between equipment providers[9]. GSM is the top-down 'cathedral', contrasted to 'medieval cities' of Herbert Simon (1981:33) and the Wi-Fi 'bazaar'. A single global standard is beneficial to the consumer, especially since it offers the advantages of interoperability; therefore, it might be better that a dominant 'Leviathan' should bring order to the Babel Tower of non-compatible standards (as in the case of mains electricity current and plugs). The GSM is the Leviathan's[10] triumph of Thomas Hobbes (1651); one standard giving motion to telephone mobility. The RF spectrum belongs to the state; its usage should be harmonised in order to benefit from economies of scale. Controlled regulation preserves and holds the RF scarce resources. RF secondary trading harms the broadcasting services, as the wealthy cellular providers will raise the price of RF; the most economic option is not necessarily the most socially beneficial. Quality of Service (QoS) should be guaranteed implicitly, via restrictive interference control.

2.4.3 The *Individualised* View Explaining Innovative Wireless Regulation and Minimal Restrictions

Markets and prices have important advantages over *central-planning* as tools for the allocation of resources (Simon 1981:34). Regulation should be based on 'sound science' and effectively reduce significant risks at reasonable costs (Slovic 2000:410). The CT *individualised market-based* view explains the existence of tolerable levels of EMF exposure and *spurious emissions*, more RF bands and powers provided to Short Range Devices (SRD)/ Software Defined Radios (SDR) / Ultra Wide Band devices (UWB), and management of RF for innovation (such as RF trading). Countries like the US, Canada and Japan that follow *market-based* rules adapt to a higher level of *human hazards* (in contrast to Italy and Switzerland), allocate more RF bands and powers to SRD (relative to Europe; see Mazar 2004:6) and manage RF for innovation. The 'Allied countries' of Australia, Canada, New Zealand, UK and USA (specified in Figure 2-2) are leading innovative wireless regulation and adoption of new regulations. A clear example of this was the US Communications Act of 1934 which implemented the risk-seeking initiative for Short Range

[9] In contrast, two different CDMA2000 suppliers (Motorola and Nortel) working with the same operator (Pelephone) in Israel do not interconnect smoothly.

Devices (SRD): to operate RF bands, that were already used (and 'contaminated') by Industrial/ Scientific Medical (ISM) equipment, for unlicensed/ unprotected ‘low power devices’ (CFR47 Part 15); Europe adopted this policy only 60 years later (ERC/REC 70-03). The explanation for this rationality may be rooted in:

Ideology: ‘Government of the people, by the people, for the people’ (Abraham Lincoln, 1863 'Gettysburg Address'). Rules limit individual freedom; whereas innovative wireless regulation and higher levels of permitted EMF, *spurious emissions* and SRD encourage the individual entrepreneur. Feedback loops[11] will solve these problems, if the limits are too tolerant. New wireless technologies (such as RF trading, SDR and UWB) are indicative of a *market-based* policy. Short Range Devices encourage investment, foster the growth of small businesses and favour them relative to big industries. The successful examples of the unregulated Internet and unlicensed Wi-Fi illustrate the call for decentralised RF innovations and minimal licensing; many heads are inevitably better than one. Simon (1981:33) has already indicated the bottom-up growth 'Medieval cities as marvellously patterned systems that had mostly just grown in response to myriads of individual decisions'. 'The State is the frame to make business easier and cheaper'[12].

Regulation: The RF spectrum is inexhaustible. The Okham’s Razor ‘principle of simplicity’ and the ‘light–touch’ approach lead to minimal intervention, higher levels of RF exposure and *spurious emissions*, and more SRD, which results in less limits placed on business. The *regulatory frameworks* of free-market countries foster innovation. RF spectrum ‘secondary trading’ leads to deregulation, liberalisation, self-regulation, fair play and ‘management rights’ by the major industry figures. The *individualist* countries also promote voluntary industry/ local authority standards, instead of government mandates. In the SRD bands, suppliers also provide services to compete with wireless operators. The 'polluters' of EMF may be trusted: they will not exceed the permitted level; their measurements are reliable. There is no zero- risk, and no total protection; 'The man, who insists upon seeing with perfect clearness before he decides, never decides' (Amiel H.F. 1872 *From Amiel's Journey*).

Worldviews: Managing RF for innovation encourages competition and contributes to efficiency, that is, the successful will survive. The regulator is a public servant, representing the individual citizen to achieve better communications at a lower price. RF innovations and new technologies are viewed as a positive **change**. Innovative wireless regulation engenders

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[10] 'that great *Leviathan* called... State… giving motion to the whole body' Hobbes (1651/1968: Introduction).

[11] ‘To explain the regulation, we look for *feedback loops* rather than a central-planning and directing body’ Simon 1981:33, cited by Smith 2002:502.

[12] ITU/BDT G-REX 2005, Virtual Conference, 29 Sept. 'Radio Spectrum Management Reform in New Zealand' presented by Brian Miller, Manager Radio Spectrum Policy and Planning, New Zealand.

fewer restrictions and promotes a *laissez-faire* and *laissez-passer* attitude. The economist's worldview is that unused RF is a waste to the economy. Unlike water and land, the RF resource is a present use: future reserves are not wasted. 'Inequity is normal, healthy and moral'[13]. The Protestant society seems more favourable to capitalism than Catholic, promoting economic growth, property rights and own responsibility. It may explain the advanced innovation in the Protestant 'Allied countries', namely Australia, Canada, New Zealand, UK and USA. Moreover, innovative countries take concrete steps to separate religion and state[14].

Regulating Uncertain Risks: higher levels of EMF exposure and *spurious emissions*, and managing RF for innovation are a result of a risk-seeking attitude. The *individualist* regulator trusts the citizen, thus giving more power and bandwidth to SRD (knowing the citizen will not exceed power or bandwidth). The trust placed in institutions favours RF limits based on scientific evidence, excluding the Precautionary Principle, as there is no cause-and-effect relationship between 'phantom risk' EMF and factual *human hazards*. Our body and wireless systems are adaptive ('benign'), so there is no need for additional protection over the international level. The technology-oriented society takes some risks: the unknown effects of increased SRD's power and bandwidth, EMF limits or the consequences of operating SDR or UWB are tolerable; economic and viable solutions should be adopted. The cost of additional RF interference from *spurious emissions*, SRD, SDR, UWB or Power Line Communication (PLC) is less than the benefit of increasing competition, in areas such as wireless applications and Broadband Internet. The US regulation is typical of a modern risk-seeking administration, permitting the entry of further users of RF: SRD (even within the licensed up-link Satellite bands), SDR, PLC and UWB cause some tolerable risk, by increasing the aggregate interference level. Italy is the antithesis of the risk-seeker; the distrust in institutions causes significant excess in EMF prudent avoidance.

Network Services: The licenses should be as general as possible, lenient and with minimal restrictions. A simple licence is easy to draft and maintain by the regulator, and simple to implement by the carrier. The regulation of the digital cellular and TV industry is neutral in technology. As the demand on the civil RF spectrum exceeds the supply, competition is the response in most RF bands (except broadcasting bands). RF secondary-trading and market transactions for the allocation of spectrum permit the 'invisible hand' in the free-market to fix the RF price, as with a private good; it initiates an optimal allocation of the RF resource to

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[13] Kasperson and Kasperson 2001:483, quoting Kahn, Brown and Martel 1976.

[14] Typical *central- planning* France is extraordinary: a Catholic country pushing assertively to separate Religion from the State in France and the EU.

the most economic candidate. The RF spectrum resource in the market can be treated like any other good. The RF Spectrum is treated as private property; the owner has exclusive and transferable rights to use, aggregate, divide, buy and sell it. Releasing much spectrum at once maximizes short-term revenues. The spectrum is used by those who value it most (wealth criterion); service providers coordinate among themselves for the best use of spectrum resources and economic efficiency. The rules should cherish the individual's entrepreneurship, innovation and wealth. One should aim for consumer sovereignty. In a climate of competition and free-market, there is no need to legislate and to impose a Quality of Service (QoS) on the cellular operator, or to insist that they provide national coverage (universal service). *Caveat Emptor* (buyer beware) and *liberum arbitrium* (free choice): the buyer is clever and will decide freely what is optimal; if there is neither a QoS nor universal coverage, he/she will not buy; there is no need for any administrative intervention.

2.5 Summary: Collectivised Central-Planning versus Individualised Market-Based

The four prototypes of *Cultural Theory* are merged into two opposing regulatory rationalities. The *collectivised-central-planning* style (*hierarchist* and *egalitarian* perceptual filters) may explain the restricted thresholds of *spurious emissions* and *human hazards*, RF harmonization and top-down technology. The *individualised-market-based* approach (*individualist* and *fatalist*) may justify the higher RF *spurious emissions* and exposure levels of *human hazards* permitted, more RF bands and powers awarded to the RF spectrum commons (Short Range Devices signify the spectrum commons), and allowing for wireless innovation. In general, countries can be divided into the *central-planning* or *market-based* rationalities; these two opposing ideologies, policies and worldviews shape the regulation of wireless uncertain risks and network services. Developed countries seek to serve the citizen-consumer better and more fairly.

Different geographies (congested Europe versus isolated USA/Canada), legal origins (more *civil law* than *common law*), the interpretation of Democracy (Thucydides versus Abraham Lincoln) and religions (more Catholicism than Protestantism) could lead the EU and the US to opposing rationalities. Many borders within Europe oblige *central-planning* and RF harmonisation; the European multi-culture (reflected in multi-languages) necessitates a cautious central ruler to avoid a 'Babylonian Tower' of standards. The procedures and the regulation in countries under *civil law* are different from the countries where the judicial system is based on the *common law*: the 'efficiency' of the *common law* versus the 'formality' of the *civil law*; the integrated centralism and supremacy of the State are typical to the *civil law* and the *collectivised* countries; in the *common law* (and *individualised* countries), there is a supremacy of the individual over the State; the legal origin may differentiate *collectivised* from *individualised* countries. The Protestant society relatively promotes economic growth, property rights and own responsibility. Perhaps it is not Protestantism and Catholicism that shape the attitude to public affairs and wireless regulation; it may be that one culture promotes individualism, free-market and freedom; therefore, it welcomes both Protestantism and the *market-based* approach; while another culture is more socially, family-orientated, to prefer social solidarity and central control. The belief in the *individualised* countries (Australia, Canada, New Zealand, UK, US) is that market forces assure the optimal distribution of RF resources; while in Europe (not in the UK) there is some distrust of the market in this area, thus necessitating more government regulation. The two ideologies result in opposing worldviews on how to achieve the most benefit to the citizen and the consumer.

This study clarifies the reasons why France led Europe and the ITU toward lower *spurious emissions*, RF harmonisation and imposed technology. The collectivist ideology, hierarchical regulation, the equity values, the need to control network services and public assets led France, Europe and other *central-planning* countries toward restrictive thresholds and RF harmonisation. The opposing policy of individualism, 'light touch', the free-market regard for network services (and RF spectrum) resulted in more tolerant levels of *spurious emissions* and EMF *human hazards* in the US, Canada and Japan (as explored also by the four prototypes, see figure 2-1). These innovative countries also allow more RF bands and powers for SRD. Similar behaviour appears in their rapid adoption of new technologies.

The classification of these two competing regulatory styles is rewarding; the filtering of the styles through ideology, regulation, policy, worldviews, values and goals provides an objective comparison, that permits the explanation of the wireless objects according to culture, and offers a criterion to categorise countries (*collectivised* France and Ecuador versus the *individualised* Allied Countries) and regions (*central-planning* Europe versus *market-based* North America). The diverse wireless *regulatory framework* of Europe, South America, France, UK, US, EU and Ecuador explored in the *Case Studies* is understood using the contrasting rationalities. The main results of the cross national study of wireless regulation – *regulatory frameworks*, *human hazards* and *spurious emissions* levels and innovative wireless regulation - are illustrated by these two poles-apart approaches.

The repetitive and consistent results correspond to the 'stability hypothesis'[15] of the *Cultural Theory*. However, the cultural separation is schematic and not conclusive; there is some 'mobility'. France is the prototype of engineering: about 300 technical persons in ANFR

[15] 'Individuals tend to remain in one of the four worldviews', Rayner in Krimsky and Golding 1992:107-8.

(*L'Agence Nationale des Fréquence*), *central-planning*, guiding[16] Europe and the world toward restrictive levels of *spurious emissions* and RF harmonisation. However, France is innovative in wireless regulation, deploying PLC (Power Line Communication), despite the proven RF interference from PLC to the Amateur and Broadcasting services. Ecuador is also typical of the *central-planning* style; however, Ecuador was the first country to modernise in South America and (among the first in the world) to introduce colour TV (in 1969). The US is the *market-based* prototype; however, the approval process in the US of wireless type is less tolerable (testing and approving every door-opener) than the European R&TTE (simple declaration of the supplier is satisfactory, without any prior intervention of the regulator). Moreover, the *Indicators* revealed that contrary to the acceptance of higher thresholds from cellular base-stations and electricity, the US is more risk averse than Europe in the allowed Specific Absorption Rate (SAR) from the Cellular terminal[17]. The SAR[18] levels and more restrictive *spurious emissions* in the GPS RF bands demonstrate that the US is not less stringent than Europe in all RF cases.

The 'rational'[19] wireless regulation is a balancing act between the *central-planning* and *market-based* rationalities, a reasonable and practical balance between risk and benefit; RF health (more restrictions to EMF and *spurious emissions*) versus economic principles (competition). There is a thin line where the opposing approaches can meet; the equilibrium depends on the engineering and market objectives associated with the service/application in question. For example: fire service communications are well managed using the engineering/technical 'command and control' model and specified Quality of Service (QoS); however, the same model does not suit cellular telephony provision (a market model), nor does it suit the operation of Wi-Fi (an open access model with no QoS specification).

2.6 Summary: *Cultural Theory* Explaining the Results

The general theme of culture influencing technical rules is an original hypothesis. *Cultural Theory* is first used to categorise countries in terms of perceptual filters. *Cultural Theory* overarches the four cultural rationalities (*egalitarian*, *hierarchist*, *individualist* and *fatalist*) and the two regulatory styles (*collectivised* and *individualised*). As risk is subjective, the four cultural types perceive the RF hazards differently, and regulate uncertain RF risks in diverse ways. The application of *Cultural Theory* to wireless regulation is beneficial; societal and

[16] The French Alain Azoulay led in Europe and ITU-R SG1 (Santa Rosa 1996) the lower levels of *spurious emissions*, against the US and Japan, seeking less restrictions.

[17] The ICNIRP and EU threshold is 2.0 watts/kilogram (W/kg), while US limits is 1.6 (W/kg).

[18] The lower SAR limit indicates the additional US risk concerns toward the individual; the precautionary action is rational, as the mobile phones transmit much closer to our head, relative to the cellular base stations.

[19] If we agree about what is rational; 'rational thinkers' often impose their own view of rationality on others.

risk conflicts can be approximated by the interactions of just four contrasting worldviews. Ortwin Renn and John Adams (see Ball and Boehmer-Christiansen 2002:21) are critical of *Cultural Theory*, because all behaviour can be described as a mix of all four types. However, the research shows that ideology, values, worldviews, equality/ inequality, *collectivised*/ *individualised*, rather than self-interest and utilities actually shape the RF *regulatory frameworks*, *societal and risk concerns*. The four cultural types, and also when merged to two styles (*collectivised* versus *individualised*), are a convenient simplification model. Using similar tools as in exploring risks to the environment, *Cultural Theory* provides a substantial explanation and illuminates the empirical results: RF harmonisation, mandatory technology, regulating uncertain risks and innovative wireless regulation. *Cultural Theory* is a general framework that may be used to predict institutional responses to the regulation of RF uncertain risks and unique allocations (like Japan). *Cultural Theory* does correlate between the cultural prototype and the organisational interest. Rooted in a similar rationality, the same countries (Canada, Japan and the US) are tolerable to RF *human hazards* and also to *spurious emissions*. The subjectivity of risk and the various rationalities (four prototypes and *central-planning* versus *market-based*) lead the research to *Bounded Rationality*. The moment we accept more than one rationality, we agree that there is no 'one absolute truth', nor one truthful rationality; therefore the rationality itself is bounded.

3 *Bounded Rationality* Explains Exceptional Decisions

3.1 *Bounded Rationality* in Wireless Regulation and RF Standards

Bounded Rationality (BR) is the second explanatory theory in the same vein as *Cultural Theory*. The four and two-fold *Cultural Theory* rationalities explained the different wireless *regulatory frameworks*, *societal and risk concerns*; while BR expands upon specific regulation and standard adoption. *Bounded Rationality* is the theory that may explain RF decisions that are not goal-oriented; the rationality may be intended but not achieved. *Cultural Theory* referred to ideology, policy, worldviews, values and goals; *Rational Field Theory* (RFT) will evaluate the *goals* in the next section. BR indicates how geography, culture and psychology impose conditions and constraints, and prevent the achievement of given goals. BR is synonymous with bounded reasoning.

3.1.1 The Model for Rational Wireless Regulation and RF Standards

There is a worldwide aspiration to rationalise international Radio Frequency (RF) allocation: 'there is a keen interest in the rational, efficient and economic use of spectrum'[20]. The ITU Radio Regulations, the ICNIRP limits and the regional standards represent the rationale, the objective correct reference; they bound the RF allocation, wireless standards, RF thresholds for *spurious emissions* and *human hazards*.

It is understood by all that the RF spectrum is a crucial national resource, and its use should be optimised. Moreover, EMF at high levels is definitely dangerous (do not try to put your hand in a microwave oven, transmitting 700 Watts at 2.4 GHz). The subjectivity and irrationality in RF emerge when allocating RF, regulating uncertain risks and adopting standards. The risk from *spurious emissions* and low EMF levels is subjective. To link objectivity to rationality: if there is a subjective explanation in a unique RF allocation, risk limit or in adopting a standard, the 'irrational' decision can be said to be not only *subjectively*, but also *objectively* rational. So according to the specific circumstances, it is the most reasonable and rational decision. In this way, we come back to the relativity of reason, truth and rationality. To complicate the situation, even the goals of wireless regulation are not clear; see next section, *Rational Field Theory*. Therefore, regulators may seek that their wireless rules are rational.

The empirical study indicated cases that deviate from what is thought to be reasonable. As the UK, France, EU and the US benefit from good wireless services, new technologies and low prices- their rules are correct, and in this way, rational. We can classify 'rational' regulation and standards to be the wireless rules of the developed countries, as explored in the case studies; their success proves the efficiency of their regulation and standardisation; therefore it can be imitated. Their *regulatory framework*, rules and standards may serve as a benchmark and point of reference. Significant deviation from the 'rational' rules indicates *Bounded Rationality*. In addition, it is assumed that the 'middle way' (*μέση οδός*, *via media*), 'average' and 'majority benefit' is the truthful way to regulate. This is the worldview, knowledge, morals and values of most religions and beliefs; the mainstream solution is the 'correct' one. As a result, relative to successful regulation and average values, a non-rational solution is an extreme deviation from the following:

— The geographical RF allocation and standardisation, and the international RF thresholds (the WHO *human hazards* and ITU *spurious emissions*);

— The observed value in *Indicators* for the *outlined* country is more than two standard deviations from the *expected value*. The statistical regressions identified the *outlined* countries and their significance by the residuals;

— Models of 'successful' regulation and standardisation, derived from 'high-quality' institutions examined in the case studies.

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[20] 'Considering d' in ITU-R Resolution 951 (Rev.WRC-2007) 'Enhancing the International Spectrum Regulatory'.

3.1.2 BR Explains 'Irrational' Decisions in Adopting TV Standards

'Passion', 'emotion' and hate may explain some 'unreasonable decisions'. It seems 'irrational' for Algeria to choose PAL; the external rationality leads to adopting the SECAM. However, given the hatred of Algeria toward France at the time of decision-making (1975), the PAL adoption is *subjectively* rational for Algeria, since France is the supplier of SECAM; therefore, the internal rationality guides toward PAL. This particular example of Algeria helps to differentiate the substantial from the *procedural* rationality.

Interesting that the same ('positive') colonialism, that encourages French-speaking countries to adopt SECAM, causes Algeria to adopt PAL; the colonial legacy that influences the American ex-colony, the Philippines, to adopt TV standard NTSC, provokes South Korea into moving away from the Japanese[21] TV standard ISDB. Therefore, the colonial inheritance can be negative (similar to the language-barrier), discriminating against instead of adopting the standards. Passion bounds the rationality and drive Latin America countries (such as Venezuela and Cuba) to discriminate against the US wireless standards. The *social networks* (*collective values* and *social institutions*; see *Theories* figure 1-1) assist to analyse the passion and ‘irrational’ behaviour. If the roots of passion originate in the inner circles (nuclear family, education, instincts), the prejudice against rules and standards is lasting; moreover, the passion circulates as *social amplification* and spreads via instincts and education throughout all the *social institutions*. This is the case in the adoption of the US TV standard ATSC in South Korea, due to discrimination against the Japanese standard ISDB. If the origin of passion and 'irrational' behaviour is a top-down political decision, such as Algeria's preference of PAL in 1975, the intolerance can be temporary. It is interesting that in the 21st century, the author was not able to find an example of a country discriminating against the European wireless standards as a result of prejudice or hatred.

3.2 'Irrational' RF Allocations and Superfluous Institutions

Countries make efforts to harmonize RF allocation without harming their national interests and needs. Setting up national regulation and standards are expensive ventures, especially for developing countries. The most significant irrationality is the fact that countries manage their own RF spectrum and standardise wireless equipment, despite the existence of RF spectrum allocation and standards generated elsewhere, at a regional level (such as CEPT) or by a super-power (the US). RF equipment, licensed and unlicensed networks deployed around the world originate mainly from the EU and US. For instance, there is no unique Ecuadorian or Peruvian RF standard or wireless equipment designated only for Ecuador/ Peru; therefore,

[21] The South Korean decision to prefer the US standards and not their neighbour's can be explained by their memories of the 1910-1945 Japanese occupation.

why do Ecuador, Peru and other South American countries require their own standardisation institute, and why do they need to test RF equipment themselves? In comparison, the British BSI and the French ANFOR national standards institutes harmonise in order to absorb into ETSI; the European EN standards take precedence over national standards; UK and France do not enforce the testing (additional to the declaration of conformity) of RF equipment, before it is allowed to enter the market. Most countries South America devise their own individual national RF allocation, preserve their standardisation institutes and invest in testing laboratories to examine wireless systems (that already operate well in Europe or US). These national attitudes have the expensive consequences of creating non-tariff barriers, raising prices artificially and delaying the introduction of new technologies and equipment.

Based on data from administrations, 'Resolution 9' of ITU-D indicates the various 'invented' RF allocations in many developing countries: these are different allocations to those stated in ITU-R Radio Regulations and regional allotments. A 'rational' solution is to choose a national political decision: to accept the US or EU *regulatory framework* for wireless equipment, standards and regulation; to follow the rules to which administrations have perhaps contributed. Thanks to this 'rational' strategy, most of the work of the wireless regulator and national standardisation institute becomes superfluous, enabling the release of energy and resources to more efficient tasks. A 'rational' regulatory style will result in less bureaucracy (that is restrictive for the economy and innovation), more stability, certainty, clarity, transparency, investment in industry and less corruption. 'Efficiency is necessarily a joint product of the rules of the institution and the behaviour of agents' (Smith 2002:517). RF is 'ether', per-se, and not associated with cultural and traditional aspects unlike defence, foreign policy, the legal system, currency, social assurance or taxes. Therefore, the reasonable and efficient rationality for most countries is to benefit from this cumulative regulatory activity and to 'climb atop the shoulders of giants'.

What are the subjective reasons for developing countries in Africa, Asia and South America not to adopt such a 'rational' course of action? The technical, objective and rational reasons are the existence of specific RF systems (mainly military) and peculiar RF propagation conditions. The decision-makers worry about retaining their national distinctiveness, whilst assimilated in an amorphous union. Therefore, administrations retain the control for a 'heavy touch' and provincial approach to regulation. In some cases, government agencies are unaware of the rules of the 'giants', when trying to invent their own wireless regulation and standards. An illustration of this is Mauritius' Decision ICTA/DEC/01/2005[22] on 19 May

[22] See ITU/BDT G-REX 2005 Virtual Conference, 29 Sept. 05 *Spectrum Allocation for Broadband Wireless Access Services in Mauritius (A Case Study)* Jerome Louis, Mauritius Director of RF Engineering and Licensing.

2005 not to adopt European or US recent rules on RLAN in 5 GHz, but to create its own specific limits. Instead of buying equipment off the shelf (modern and cheap), vendors should adapt the RLAN to Mauritius' local standard.

A Subjective Rationale not to Harmonise Standards in South America

Keeping control of national regulation and standardisation is another possible reason for the lack of integration and harmonisation in regional institutions. The localism and splitting of local leadership, in South America Andean countries, under various *Caciques* ('tribal chief' in Latin America), *Incas* in the South and *Shyris* in the North, demonstrates the culture of provincialism and fragmentation. It may explain why four *CAN* (Bolivia, Colombia, Ecuador and Peru) countries in the Andean community, sharing the same language, religion, legal origin, colonial inheritance, geopolitical influence, tradition, geography (tropical invariant climate) and history (Simón Bolivar) are unable to agree on a single harmonised market; compared to the 27 European Community Member States. The *Cacique* attitude may also explain why wireless national regulation is dispersed among so many institutions in Ecuador (CONATEL, CONARTEL, SENATEL and SUPTEL), relative to the converged UK (with its Ofcom), USA (FCC and NTIA only) and France (ANFR, ARCEP and CSA). The *CAN* countries prefer to bear the imprint of past organisational traditions and follow a unique national path of development.

This insistence on national regulation and standardisation is a *substantive* and *objective* irrationality; similarly for the RF non-harmonisation in South America. However, this policy represents a *procedural* or *subjective* rationality. First their Parliament did not ratify the supranational rules of EU (e.g. the R&TTE Directive; EFTA countries did approve it). By accepting the rules and procedures of intergovernmental institutions, and by realising regional harmonisation and standardisation, the Member States actually concede some of their sovereignty, lose their national 'touch' and reduce administrative employment. In addition, administrations fear losing part of their patriotism, nationalism, tradition, legislation, sense of self-belonging, particularity, personality, identity and their sovereignty. 'National regulation is the bulwark of sovereignty' (Hills 2002:292); this research teaches us that administrations use the regulation and standardisation of wireless communications as a national *collective value*. RF rules and standards are developed globally and regionally, therefore national regulation -like language- is the bound of nationality, the utterance of policy, the police (*πόλις*) of citizenship, the framework of self-government and the defence of independence. From this perspective, the RF *regulatory framework* of South America to keep national regulation and standardisation institutions is rational; the pooling of sovereignty and decision-making powers in harmonised Europe is objectively irrational; in

Europe there is no national independence in RF ruling and no more French or German cathedrals (such as SECAM and PAL standards).

Europe is more inclined towards reunification, whereas the South American countries have the tendency of preferring to remain segregated; the RF regulatory harmonisation is only one indication of these traits. South America never succeeded in implementing similar structures. Latin America is not moving toward harmonisation; preserving their sovereignty is most essential; they execute disjointed national RF regulation and standards. This can be perhaps explained by the long Spanish control exercised on the region and the reaction which followed independence.

3.3 Geography and Culture Explain *Bounded Rationality*

Topography, Bordering and Longitude to Explain Exceptional Findings

The topography of a country is implicit in RF planning: mountainous countries need more broadcasting and cellular towers, in order to provide an appropriate coverage in the valleys; moreover, the masts are more visible at the peaks of the mountain. This might be one of the reasons why Italy and Switzerland are less tolerable to cellular *human hazards*, in comparison to Holland and Belgium. One of the reasons why Chile is not a Member State of *CAN* is that the Chilean Andes block the RF signals, and make the VHF /UHF harmonisation of Chile with the *CAN* countries unnecessary. The density of countries within a certain continent and the manner in which they all border one another imposes lower *spurious emissions* in Europe. Strict *spurious emissions* and lower permitted powers to Short Range Devices (SRD) ease coordination among states and within the country.

All South American (SA) countries on the western side of the continent operate the US NTSC system, while the countries on the eastern side operate PAL; moreover, the satellite broadcasting signal covering North America and the west part of South America is well received only if the receivers employ the same US standard NTSC; this is also the case for the east part of South America getting the PAL signal from the European satellite. The vicinity to US (western SA) relative to the vicinity to Europe (eastern SA) may explain the diverse geopolitical influence and standards.

Geopolitical Influence to Explain 'Irrational' Allocations

Geographically, Egypt, Israel, Jordan and Saudi Arabia are located in ITU-R Region 1, but they operate American mobile systems in the bands allocated to the broadcasting services. Since Europe excommunicated Israel before 1990, Israel approved the American cellular standards AMPS, NAMPS, TDMA and CDMA, in the RF allocation of Region 2 (America). The pressure to introduce the US iDEN system to Jordan and Saudi Arabia caused the irrationality of allocating a mobile system in the broadcasting bands (as in Israel). This initial ‘irrational’ RF allocation causes problems in rationally allotting DVB-T channels in all the Middle East, and prevents Israel from operating extended GSM (below 890 MHz) and RFID (865-868 MHz) in the European RF bands.

Latitude to Explain Exceptional Findings

The distance from the Equator influences the income of a country and therefore the penetration of cellular and new technologies within its markets; so, latitude influences the development status and the cellular penetration. The underdevelopment of tropical countries may be rooted in their 'irrational' regulation; worldviews, values and beliefs (related to geography) could cause ineffective *regulatory frameworks* and institutions, resulting in incorrect wireless regulation and under-development of countries.

In *Cultural Theory* a link was traced between the conservatism of the Tropics and the 'no-change' attitude, climate and colonial settlements (colonisers and entrepreneurs preferred to settle in a similar climate of their homeland, such as the US, Canada, Australia and Argentina). The differences in cultures and spirits of East-West and North-South might be a result of their differing attitudes to change and dynamism. Hindus claim that which changes is the appearance, the *maya*; and that which never changes, is permanent *brahma*. The West says just the opposite: that which appears permanent is the appearance, and that which changes is the permanent: ‘you cannot step twice into the same river’, according to Heraclitus[23]. The spirit of the West is movement, flow, imagination and readiness to change. 'The *individualist* has been watching a scene that he sees changing kaleidoscopically from day to day; he is used to change' (Douglas and Wildavsky 1982:99). The argument for change varies among cultures. The gap between tropical/ non-tropical countries may be also related to tropical conservatism (no-change attitude) and to the Tropics' lack of seasons. Between the Tropic of Cancer and the Tropic of Capricorn there are no seasons, as the sun is never very low in the sky, so it stays warm and humid ('tropical') year-round. Moreover, due to the different climates, in the Northern hemisphere, the South is more agriculturally-oriented than the Northern industrial strongholds; agriculture is more static than industry. In addition, Southern Europe is more Catholic, favours the *civil law* and more conservative than the Protestants, preferring *common and Nordic laws* in North Europe. To support the idea of 'change', the 'Lex Mundi Project' (Djankov *et al.* 2003:7-8) indicates that the advantage of the *common law* is its flexibility and continuous change. The attitude toward 'change' versus 'conservatism' of the individuals and the decision-makers is deep; see Figure 1-1 'spheres of influence: *social networks*', in the *Theories* chapter. The change/no-change *collective value* is shaped in the nuclear family; it is influenced by the religion, authority's acceptance, education and **geography**. The organisation of the *social institutes* (city, country and at intergovernmental levels) may reflect and reveal the approach toward change.

Regarding latitude, the European *case study* showed:

- South Europe receives TV signals mainly terrestrially, compared to Northern countries;
- The penetration of cellular services in Protestant and Catholic countries in Europe is higher than in Muslim and Christian Orthodox states;
- 'Northern Europe is the continent of the cell phone';
- The *human hazards* thresholds of North Europe are more tolerant, relative to the South.

These results indicate *objective* irrationalities, but also a *subjective* rationale:

- In Southern Europe, citizens expect to receive their TV signal also when outside their home, e.g. when in camping or at the sea shore;
- Northern Europe is more Protestant than Southern Europe. In parallel, North Europe is richer than Southern Europe; see *Indicators*, figure 2-4 'cellular penetration versus income';
- The correlation of cellular rate and religion is linked through income. Income and latitude are strongly correlated all over the world; see *Indicators*, figure 2-6 'cellular penetration versus latitude'. The fundamental proof of this is the tropical under-development;
- The leadership of the Scandinavian countries in cellular penetration is rooted in the fundamental necessity of mobile telecommunications in this region during winter storms, while driving between cities to isolated locations;
- Northern Europe holds a positive attitude toward the GSM industry which is indispensable to the Scandinavian economy. Moreover, the Northern population is more tranquil and restrained; it is more difficult to take them out, to get rid of the cellular towers by burning them (as done in other 'southern' countries).

Language Explains Unexpected Results in Adopting Analogue TV

The official language serves this thesis to convert some *objective* irrational decisions to *subjective* rationalities. Language is a most dominant statistical ‘instrumental variable’ in determining the adoption of analogue TV, and is capable of evading geography. The decision of French-speaking (24 out of 27) and ex-USSR states (all 12 countries) to adopt SECAM is not *objectively* reasonable, as the PAL system matured jointly with SECAM (1967), and PAL succeeded both in the UK and Germany and in most countries around the world. Moreover, SECAM is not a better system than PAL; the systems have been compared on a technical level by both Argentina and Israel. The adoption of SECAM is an example of

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[23] www.brainyquote.com/quotes/quotes/h/heraclitus138514.html 27/2/08; Heraclitus of Ephesus (*ca.* 540 BC-480 BC).

the influence of language (not necessarily a direct influence), with the intention to specifically exclude the *βαρβαρων* (other): PAL and NTSC standards represent the foreigners. The same *objective* irrationality is revealed in the Spanish-speaking countries' adoption of PAL (16) and NTSC (5). Of the 59 countries whose official language is English, all except Mauritius[24] exclude SECAM. Therefore, for Spanish and English-speaking countries, SECAM represents the outsider. The use of the same language alleviates the adoption of analogue TV standards; and inversely, different languages may cause a barrier.

The US is Prisoner of its Worldview

The success of the European cellular industry (base stations and handsets) can be explained by the traditional US policy of technology neutrality in licensing, the relative low cellular penetration rate in the US and the high quality of wired communications. The US *case study* detailed one of the causes: the US/ Canada decision not to apply 'Calling Party Pays' (CPP); in the US and Canada the cellular Receiving Party Pays (RPP). The calling cellular party (call originator) pays for the service in Europe and in most of the world; such a payment policy would augment the cellular growth rate. Top-down enforcement of a technology or standard, twenty years ago, would have enabled enhanced cellular interoperability and roaming capabilities in North America. Such a step, along with CPP, could have pushed the American CDMA to surpass the European GSM and UMTS markets. However, those two changes are unlikely to occur in the American culture: in the first case (neutral technology), the freedom to choose technology is crucial in the US; and in the second case, the caller should know the exact cost of the phone call (when phoning to a cellular device).

Bounded Rationality and the Perception of RF Radiation

There is more activity in developed countries concerning contemporary sensibilities such as EMF, than about war and economics, with a much more significant and tangible impact. Most countries did not set their priorities as regards RF risks. As there is no direct comparison of benefits with costs in EMF, money is being spent disproportionately to any actual benefit. The furore over masts is an example that teaches about risk and rationality. People are sensitive to see cellular antenna masts in their proximity, also for fear of cancer which may be caused from exposure to the RF radiation. However, they do not realise that the main electromagnetic exposure comes from the cellular handset, due to its proximity to the human head. From the point of RF risk exposure, the more cell site antennas, the lower the EMF required for efficient communications, both from the cell site and subscriber unit transmitters. Spreading this scientific information may save some 'irrationalities' encountered

[24] Mauritius was colonised first by France till 1810 and then by UK till 1968; see *Indicators* subsection 2.2.5.

today with the construction of new cellular cell sites. May be, public reaction is reasonable: people do not want a mast (involuntary risk) erected near them, but do not object to their children (voluntary risk) using mobile phones. May be, it is not the (involuntary) risk they object to, rather what they see as the exploitation.

3.4 Bounded Rationality - Summary

The behaviour of administrations is intended to be rational, but is only so in limited scope (Morand and Stagl 2001:6, citing Simon 1985). The empirical *Indicator*s chapter indicated the expected values and the extremes in analogue and digital TV norms, RF *human hazards* and *spurious emissions* levels. The successful e-Communications in France, UK, USA and Europe serve as a reference for regulation; their rules are 'rational', well established, stable, coherent, transparent and balance the interests of all players. The international and regional level or the statistics of expected RF standards provide the 'rational' solution. Any unique regulation or standard is *objectively* 'irrational'; the *Cultural Theory* offered a rationale for the RF uniqueness of Japan. The *collective values* provide the attributes necessary to bridge between the correct solution and the present wireless situation. *Bounded Rationality* transfers *objective* irrationalities to *subjective* rational decisions. Like the risk, the RF decisions are explained *subjectively*; the *subjective* explanations rationalise the decision-behaviour.

'Unreasonableness is a problem that increases with the size of groups' (Van de Kragt 1983:112); there are four RF regulators in Ecuador. Developing countries invent rules, create their own national regulation and maintain their standardisation institutes, even though their wireless equipment and systems are imported. The foreign wireless equipment (originating mainly in the Europe or the US) should in theory engender the *regulatory framework* (the RF allocations and standards at the exporting country): to save bureaucracy, to open wireless markets to competition, new technologies and to offer more overall employment. Instead, the poor countries invent national regulation and standards. The fear of losing sovereignty and reducing present levels of clerical employment serves as the *subjective* rationale for such complicated *regulatory framework*.

The geographical longitude (ITU Region 1, 2 or 3) should be the main factor to consider when adopting national wireless regulation and standards. However, due historical events and geopolitical influence, countries regulate differently, and cause unnecessary interference; mistrust causes countries to adopt standards incompatible with those of their neighbours. The decision behaviour of South Korea (distancing itself from Japan) and Algeria (banning French SECAM) illustrate the *Bounded Rationality*.

In some cases countries are prisoners of their worldviews; this is the case of the neutral technology in the US cellular industry: there is no one standard enabling wireless interoperability of cellular phones in the US and outside, in comparison to the national and worldwide interoperability of the European top-down mandated GSM technology.

A common language engenders trust among regulators and standardisation institutes in different continents, connects wireless vendors to service providers and allows for the spread of standards (e.g. the French SECAM, and the ultra-low *human hazards* levels shared by Italy and Switzerland). Different languages handicap communication and the spread of RF standards: no Spanish-speaking country operates the SECAM system, and only one English-speaking country (Mauritius) does so. These are examples of 'irrational' distrust against those who do not speak your own language (*barbarous*). In regulating RF *human hazards*, government agencies react to 'subjective, often hypothetical, emotional, foolish and irrational'[25] anxieties of the public; cities alienate antenna masts from populated areas, but by doing so the radiation (in the populated areas) from cellular handsets augments.

Geography and culture can explain the different risk perception, hazard tolerability and thresholds around the world. The awareness that their rationality is bounded and understanding the possibly self-imposed or externally-imposed boundaries (of cultural and geographical factors) may give regulators more freedom to allocate and license RF. *Bounded Rationality* joins the *Cultural Theory* (CT) in clarifying the empirical data on RF allocation and licensing. The attitudes of national administrations are logically explained, even if some decisions seem irrational; there is a logical explanation also for irrational behaviours. The *social networks* and *collective values* are the roots of the different styles and rationales. The reader may understand the different decision-behaviours by relating them to multiple rationalities. The four CT prototypes of decision-makers, the *central-planning* versus the *market-based* rationalities and the *Bounded Rationality* generate disparate *regulatory frameworks*, *societal concerns* and *risk tolerability*. The *Rational Field Theory* will add the role of values, beliefs and goals to understanding the disparate rationalities, creating a general tool for a regulator to enable the RF regulation, standardisation and thresholds' limits to be chosen rationally.

4 *Rational Field Theory* (RFT) Explores the Findings

4.1 *Societal Concerns*, Culture and Values Shape Wireless Rules

In this research, the *Rational Field Theory* (henceforth RFT) analyses the rationale of the *regulatory framework*, the regulation of uncertain risks (RF *human hazards* and *spurious emissions*) and adoption of RF standards. RFT analyses fewer, but 'superior' conflicts, to be better focused on practical subjects. RFT looks at philosophical topics related to how far we want to go in implementing safety measures, what we are prepared to sacrifice in achieving certain *goals*, and how we should choose (see Ball 2001a.:3); the *rational fields*[26] are the product of choice. RFT contrasts worldviews by separating the problem into *rational fields*. RFT contrasts the two most influential RF *regulatory frameworks*: EU versus the US; RFT explores *human hazards* and *spurious emissions*. In the three cases discussed here, two opposing solutions are proposed. During these three debates, the two conflicting groups claim that their goal represents the public good and utilitarianism: maximising the good of society (Jaeger, Renn, Rosa and Webler 2001:38), the greatest good for the greatest number (Bentham 1789 and Mill 1863) and the most efficient method 'Pareto' of allocating society's resources (Altman 2001:173-6). The three cases depict clashes between two opposing rationalities and *rational fields*. So, RFT explains the findings and contributes to understand the empirical results.

'What we must do is reflect society's values at large' (Adams and Thompson 2002:1); *values* and not evidence drive opinion on what is good for wireless regulation. The two sides are convinced that their *values* offer the solitary common goal to maximise or optimise everyone's own utility. RFT illustrates the two alternatives, focuses and clarifies the risk debate, the clash between opposing *goals* and the conflicting *values*. The poles-apart beliefs and *values* lead toward incompatible *goals*, *strategies*, *means* (to achieve the *goals*) and *instincts*. RFT openly acknowledges that there are no absolutely right answers. The wireless *regulatory framework* is not value-free; there is more than one way to regulate RF.

'The *societal concerns* are characterised according to the motivations which are likely to underpin them' (Ball and Boehmer-Christiansen 2002:6); different worldviews result in opposite *goals*; so, the methodology in this section is twofold, due to the conflicting *goals*. The RFT templates set out the plan systematically and allow the testing of policy objectives, priorities, lead concerns, sensitivity to *societal and risk concerns*, trust in institutions, coherence, likely benefit and likely cost. The templates classify and contrast the wireless process using the conflicting *values*, *instincts*, *means*, *strategies* and *goals*; the templates are self-explanatory. The first RFT template Figure 4-1 reveals and illuminates philosophical and regulatory questions concerning *values* and *goals* in the administration's choice: the adoption of EU versus US wireless standards. Figure 4-2 illustrates the permitted thresholds of RF *human hazards* (from cellular stations and electricity) and Figure 4-3 depicts *spurious emissions* of wireless transmitters. The first debate discussion relates to the global policy, the national RF *regulatory framework* and its rationality; while the two other conflicts are

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[25] These are Slovic's adjectives, chapter 5 in Krimsky and Golding 1992:117-52.

[26] *Rational fields*, *values*, *goals, instincts, means* and *classifications* are *italic*ised.

connected directly to uncertain risks. The main viewpoint is through the eyes of the state regulator; the political objectives, *goals*, *values* and *instincts* of the civil servant and elected decision-makers echo the national culture, worldviews and public divide. The RFT is less schematic than the 'four-fold' and 'two-fold' cultural typology; RFT enables 'mobility', since it explicitly recognises that decisions, which are taken by people and organisations, are functions of *instincts, values* and *classifications*, all of which are operative.

4.2 Adoption of European versus US Wireless Rules and Standards

The first conflict to be analysed is that of whether to follow the European or the US regulation and standards. *Indicators* demonstrated that for the state regulator there are two global leading wireless paths: the European and the US regulation and standards. Unlike other markets, the wireless industry is mainly a duopoly of two superpowers: the EU and US. In the 20th century, Japan did not succeed in exporting its successful wireless technologies (cellular PDC and digital TV ISDB-T); in the 21st century, China is developing RF standards (cellular 'TD-SCDMA' and digital TV 'DMB'). The *Case Studies* and *Indicators* showed that the US rules are not accepted 'as is' in Ecuador; just as the EU directives are not accepted blindly in CEPT countries outside the European Commission (such as Russia and Turkey). National administrations can influence regional regulation, by participating in and contributing to the standardisation process. The uncertainty about the regulator (EU versus US) is a '*Domine quo vadis?'* (Lord, where are you going?) cultural decision, based on a sense of belonging and national defining identity. The question on an international level is to which hemisphere to belong, to follow the regulation of Europe or the US? The template in Figure 4-1 analyses and explains why countries adopt either EU or US standards. The influence of the EU and the US on regulation and standards is through political and economic engagement.

The two opposing standards were the analogue TV European PAL and SECAM versus the American NTSC; the competition now is especially tense between the digital TV DVB-T versus ATSC, and between the third generation cellular UMTS versus CDMA2000; the standards of the EU and US compete in each market. The decision-making itself is a source of controversy; the two choices are substantially value-based. Such choices are still treated as though they are open to solution by 'rational thinking'. Apart from EU, USA, Canada and Mexico, most countries have not yet decided which wireless direction to follow. *Indicators* demonstrated that ITU-R Region 3 countries (such as Australia and Japan), the Middle East (Egypt, Jordan, Saudi Arabia and Israel) and Latin America (such as Argentina and Ecuador) operate the EU and US standards in parallel. For the countries that remain undecided, Figure 4-1 may serve as a rational tool in deciding which hemisphere is preferable.

The ITU Radio Regulations allocate the RF spectrum according to three geographical Regions. The location of the country in ITU-R Region 1 naturally conducts Europe, Africa and the western part of Asia towards EU rules and standards. ITU-R Region 2 guides the American continents towards the US regulation. ITU-R Region 3 (part of Asia and Oceania) has no leadership (China or Japan), nor a central regional regulation (APT is not dominant like CEPT or CITEL); countries adopt either the EU or US regulation.

Culture, especially language (indirectly) and legal origin, also pushes countries towards either the EU or US regulation. French-speaking countries, members of CAPTEF and FRATEL, located mainly in Africa, can be identified by their SECAM TV system; they are inclined towards French rules and standards; therefore they may follow EU regulation and standards. The same goes, but less significantly, for Dutch, Danish, German, and ex-USSR countries. Following the Memorandum of Understanding signed with CEPT (in 1999), the Arab countries adopt the EU regulation and standards (such as DVB-T and UMTS). The plan RRC-06 also guides participating countries to adopt the DVB-T standard; thus through regional 'technical' compatibility and avoiding interference. English-speaking countries are split between the US and UK influences. The areas of contention lie in the TV standards, mains electricity current and driving side: with PAL, 50 Hertz current and left-hand driving for the UK; versus NTSC, 60 Hertz electricity current and right-hand driving for the US. This distinguishes between the distinct regulatory roots and differentiates the UK from the US' geopolitical influence. Spanish and Portuguese countries are also divided between the European and the US geo-policy: Spain, Portugal (on one side) and the US (on the other side) influence Brazil (more oriented toward Europe) and the Spanish-speaking countries in Latin America. The French, German, Nordic, and Russian legal-origins guide towards the EU regulation. It is important to notice that government agencies are conservative and do not change their traditional ways of doing things; so, past and present decisions taken on regulation and standards lead into the adoption of wireless standards (such as 3rd generation cellular equipment or digital TV).

The geopolitical influence and colonial heritage of a country are linked to culture. Geo-policy plays a role in the decisions on regulation and standards. Countries that obtained their colonial heritage from France, UK, former USSR, German, Denmark, Netherlands, Belgium and Italy are candidates to follow the EU. The candidates to follow US regulation are the US' colonies (e.g. Virgin Islands), the US' neighbours (NAFTA members- Canada and Mexico), the users of ‘01’ US country code for their phones, users of the US Dollar as official currency or countries transferring their power to the US at ITU conferences.

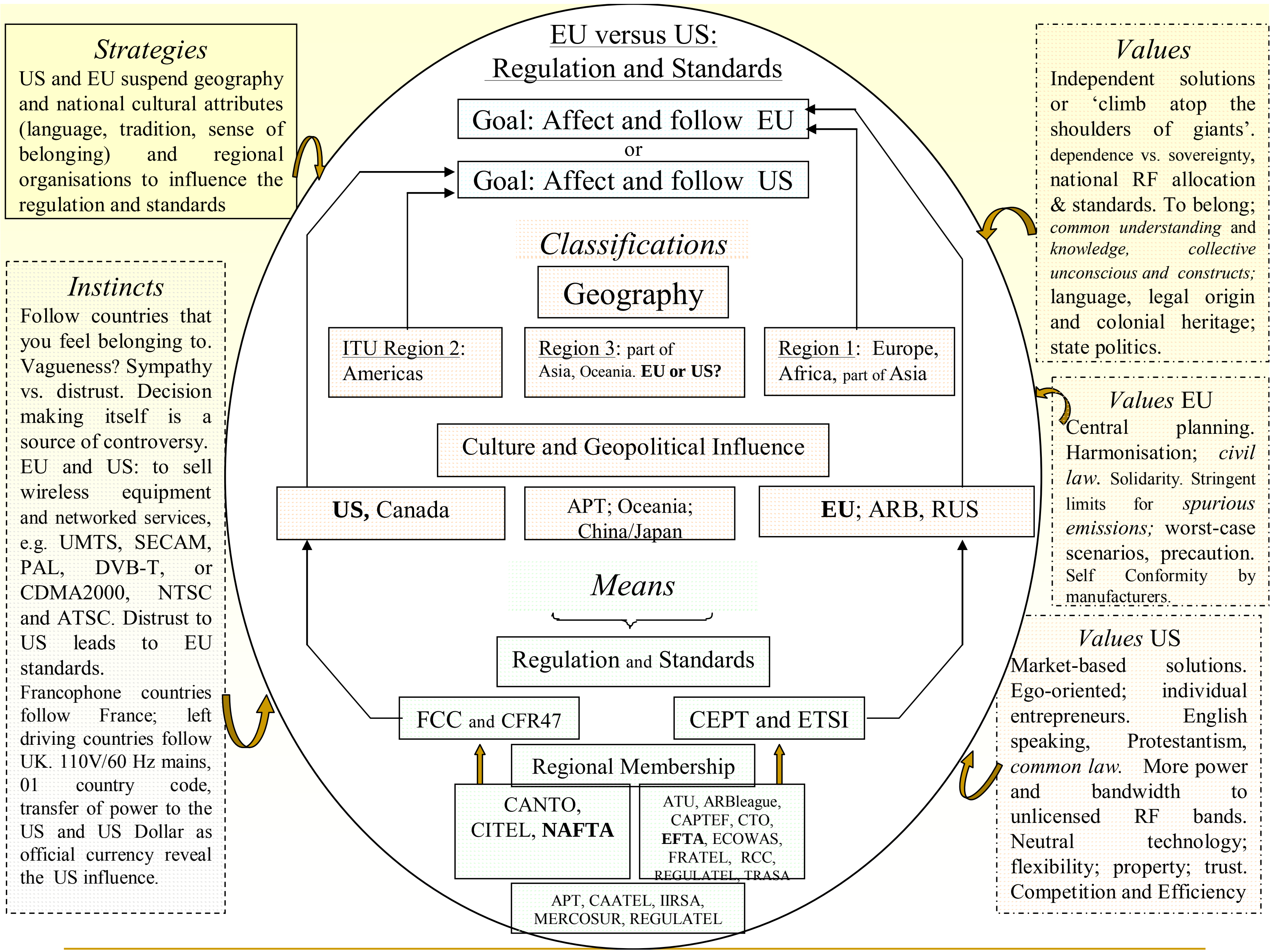

Figure 4-1 RFT template: EU versus US; regulation and standards

Protestantism may assist in adopting the US market-base and risk seeking global view; the empirical data showed that this religion may promote Capitalism, relative to other religions. Protestantism, the *common law* and English-speaking characterise Australia, Canada, New-Zealand, UK and USA (denoted in Figure 2-2, perceptual filters); all of them apply innovative wireless rules. The *instincts* play an important role in the decision; *Indicators* pointed out certain 'bounded rationalities': adoptions of wireless standards (PAL in Algeria and ATSC in South Korea) that may be explained by distrust. For historical and geopolitical reasons, Region 3 countries like Micronesia, Philippines, South Korea and Taiwan sympathise with the US; they all also operate the US NTSC colour TV system and 60 Hertz electricity current. Other Region 3 countries (Australia, India, New Zealand and Singapore) are more connected to the UK; they all operate PAL, 50 Hertz electricity current and drive on the left-hand side. Distrusting USA leads toward European RF standards. After deciding between the competing EU or US spheres, implementation is carried out by adopting the EU CEPT regulation (such as the RF Allocations of ERC Report 25 and Short Range Devices recommendation ERC/REC 70-03), ETSI standards (DVB-T and UMTS) or the US FCC Code of Federal Regulations 'CFR-47'.

The decision whether to implement EU or US regulation could remain vague. Vagueness might be useful when a country (like Australia, Egypt, Jordan or Israel) is unable to make an official statement supporting either the EU or US rules. Seedhouse (1997:71) and Altman (2001:34) support some vagueness in the *goals* of *rational fields*, to accommodate the behavioural conflicts.

The regional membership is a *means* for the EU and US to spread their regulation and export their wireless equipment and services. Member states of CEPT and NAFTA follow (by definition) the European and American rules; CITEL members are more inclined towards the US. Moreover, the regional communication organisations reflect also the linguistic *classifications*; e.g. CAPTEF, FRATEL and RCC; see *Indicators* Table 2-2 'Main International Administrative Organisations' and the abbreviations list. In addition to geography and culture, *values* and state politics can push countries toward either the EU or the US. EU is more of a *central-planning* top-down governance compared to the US *market-based* approach. Socialism, solidarity and left-wing policy may fit better to a European inclination; whereas capitalism, individualism and right-wing policy correspond more to a US geo-policy.

4.3 RFT and Regulation of Uncertain Risks

The allowed threshold of the RF *human hazards* and the permitted *spurious emissions* are examples of regulating RF uncertain risks. State-regulators are convinced that their chosen way is the optimal one to serve the public interest. The *Indicators* and *Case Studies* indicated that Europe authorises lower *human hazards* and lower *spurious emissions* thresholds, whereas USA, Canada and Japan allow more tolerable limits. The EU is more sensitive than the US, Canada and Japan to wireless ‘environmental’ issues. These RF hazards have already been analysed by the *Cultural Theory* and *Bounded Rationality*. RFT reveals the cultural roots, entrenched in diverse *values* and *instincts*, which lead to different *goals* and *strategies* in regulating RF risks. In considering the risk of RF activity (EMF from cellular and electricity lines), it is essential to take account of its benefits; RFT also considers the benefits to business from services of general economic interest or equipment causing *human hazards* and *spurious emissions*. RFT explores the meaning of safety and balance. RFT includes value judgement: is it more important to protect the public from harm (risky technologies, such as cellular towers and electricity lines) and the RF spectrum (from high *spurious emissions*), than to ensure welfare (benefits from technologies such as third generation services, cellular coverage and reasonably priced electricity) and inexpensive RF equipment?

4.3.1 RF *Human Hazards*- Human Health versus Business

The conflict to be analysed is to whether cost-effective networked services (cellular and electricity) or lower RF *human hazards* limits should be preferred by the regulator. *Indicators* classified countries into those implementing the EMF ICNIRP levels (most of the countries), those increasing ICNIRP level (US, Canada and Japan) and those decreasing the thresholds (*e.g.* Italy and Switzerland). The main conflicting *strategies* for the state regulator are whether to follow the international (ICNIRP), or to create national thresholds.

The total health promoters are anxious about any irreversible harm that may be caused to future generations. They fight to remove all cellular and electricity sites from populated areas, as the risk is unacceptable to them, their aim being to achieve zero-risk. They believe that the hazard is not being properly handled; the media (at least in Europe) and Internet amplify their manifesto. They refuse to accept the expansion to 3G cellular technology, as it boosts the proliferation of cellular phone masts. They fight to lower the EMF thresholds. People interested in business advocate the quality of networked services; they support these installations in proximity to the consumer, limited only by engineering constraints. For them the EMF risk is tolerable; technical and scientific information will calm the public, and the benefits to the community should be published. Their main *mean*s of accomplishing their *strategies* and *goals* is to advance high EMF thresholds.

Human hazards are highly specialised subjects, arousing public concerns; the thresholds are politically driven; the balancing act between the two competing groups shapes the adopted *human hazards* levels. Achieving a balance between tangibles (3G new services) and intangibles (*human hazards*) is difficult, particularly in a science-dominated culture; human intervention and judgement are needed. No mathematical formula could ever solve this conundrum. The *values*, *instincts*, role of the media and Internet ('e-rumours' circulated on the Internet), views on vulnerability of the human body and risk perception are all conflicting. The sociological, cultural, institutional or political backgrounds are different; EMF thresholds reflect factors like the political power of the environmental parties and the perceived benefits of new technologies (such as 3G). The obedience to rules and their enforcement also influence the *human hazards* threshold. In the US, Canada and Japan obedience (as a *value)* is high, in comparison with Italy (thousands of illegal broadcasting AM and FM stations, and untrusting governments). So, the *human hazards* (and *spurious emissions*) level in the US, Canada and Japan can be high, since the threshold is kept and enforced. The *collective values* authority's acceptance and obedience, rooted in family *values* (see *Theories* Figure 1-1 Spheres of influence: *social networks* and interactions), do explain fundamental differences in *societal and risk concerns*, in wireless rules and standards.

The devaluation of property is another factor in the debate about siting the base-stations and electricity. A purely economic cost-benefit approach decrees the optimum position to the least advantaged locations; however, a positive discrimination such as 'North may surrender power to South'[27] can be considered[28]. This conflict requires a moral decision: economically, site the tower in a poor quarter, to minimise devaluation and siting expenses; however, is it correct to discriminate against the powerless? In this case, the poor are (not) represented by the *fatalist* prototype; they are the 'forgotten groups' and the 'omitted voice' (Graham and Wiener 1995:230).

The template in Figure 4-2 explores the EMF risks versus the benefits of networked services. The discourse reveals the subjectivity of truth and the definition of scientific evidence. The opposing groups also disagree about the risk itself. Certain questions that should be posed: how can we prove the <u>in</u>existence of a certain factor (of harm, in this case), the VOID (empty) group? How should the permitted level be defined? Are 'electro-sensitivity' (obsession with RF emissions), hypothetical 'phantom' risks and public psyches also hazards that the regulator should take into account, as they degrade the public health? How can nuisance caused by RF emissions or electricity be defined? Regarding evidence- how evident is the injury? What is the certainty of evidence? Seedhouse (2002:70, figure 10; see *Literature Review*, subsection 4.3.3) defines the types as within-the-evidence and beyond-the evidence. *Human hazards* risk is neither type 1, 'it just is', nor type 2, 'speculations that can be tested by reference to evidence'; *human hazards* is type 3, 'speculations that cannot currently be tested by reference to the evidence'. But lack of definitive evidence does not signify a lack of awareness to this risk, to which more than three billion persons using cellular phones are exposed.

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27 Kasperson and Kasperson (2001:483), citing Leontief, Carter and Petri (1977).

28 Another account on ethical-utilitarianism and preferential support for the weakest appears in Goodale and Cooper (1990), Graham (2001), Rawls (1971) and Rawls and Kelly (2001).

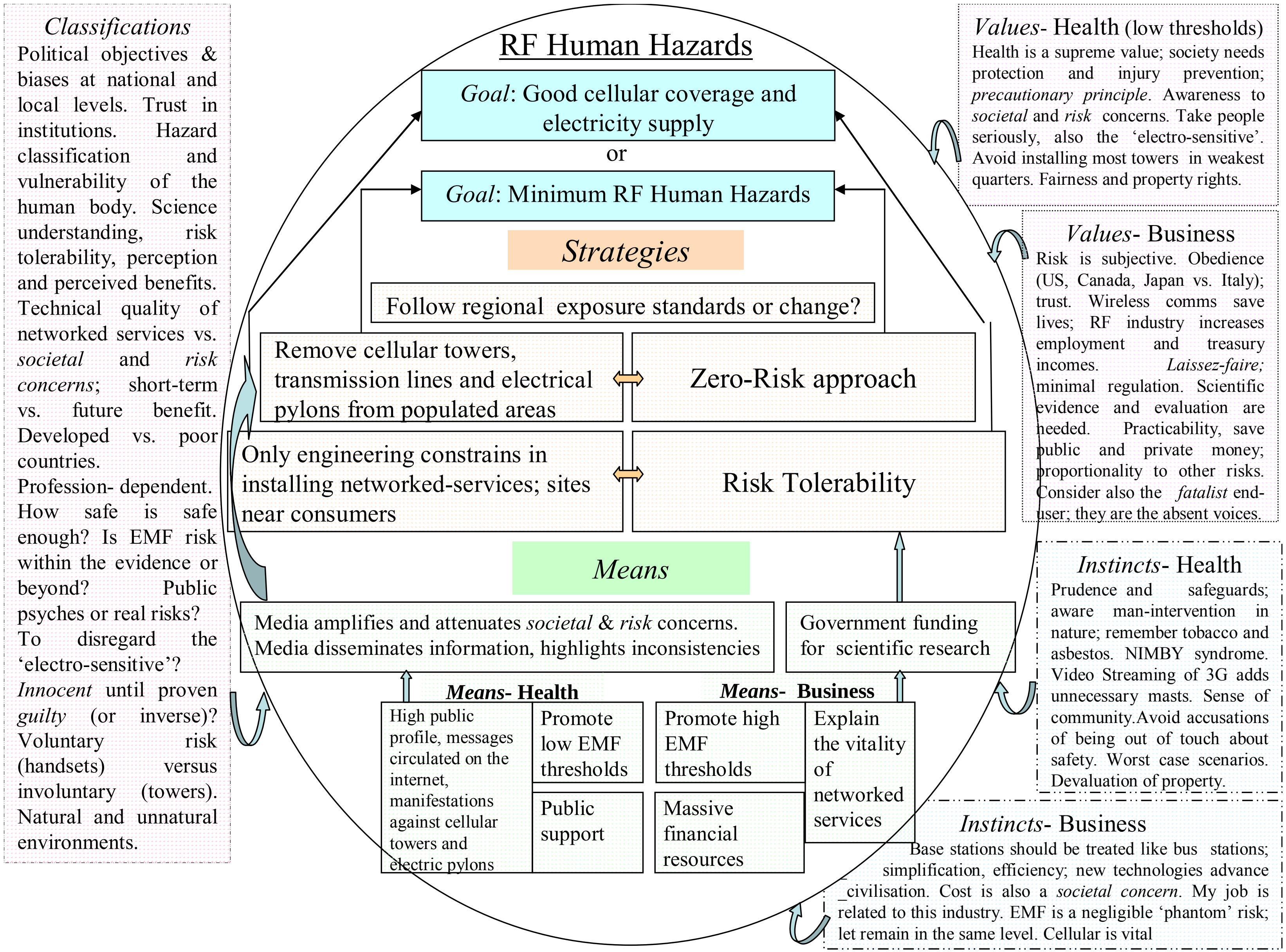

Figure 4-2 RFT template: *human hazards*

The *values*, biases and priorities are poles-apart; for the countries choosing lower thresholds than the international level, health is a supreme *value*; society needs protection, injury prevention and precaution. These countries are more conscious of *societal and risk concerns*, environment and public feelings; they worry about accusations of being out of touch about safety. They take people seriously, even if they suffer from 'electro-sensitivity'. For countries preferring higher thresholds (less tolerable), the priorities are different. The more tolerant countries emphasise that wireless communications save lives, and the RF industry increases employment and treasury incomes. They prefer a *laissez-faire* approach with minimal regulation. As they are uncertain about the risk, they seek scientific evidence and proportionality to other risks. They are practical, in order to save private and public money.

The risks are either socially-constructed or objective. The RFT template illustrates the two opposing approaches toward *human hazards*. In a pluralist society, pluralist preferences for risk must be anticipated. In a democratic society, all of these preferences should be heard and encouraged to be heard. Other than in those cases where *societal concerns* are generated by self-gain, the right to hold different perspectives should be respected. The communication and discourse are complicated: people and decision-makers are naturally biased. It is impossible to convince the 'electro-sensitive' that cellular and electric lines are not dangerous; it is also hard to persuade the cellular and electric industries to spend resources on risk that is not immediately evident. It is interesting that the *regulatory frameworks* of the developed countries are similar, but poor countries regulate in their own way; however, regarding the regulation of *human hazards*, developed countries invent their threshold, their national rules, and many cities invent their local limits.

4.3.2 *Spurious Emission* Levels- RF Health versus Business

The conflict is whether to enforce the European strict limits, or the more liberal thresholds of the US, Canada and Japan; the effective use of RF resources, versus the equipment's price. The case studies exposed contrasting numbers for the levels of *spurious emissions*. The main conflicting *strategies* for the state regulator are: should the RF spectrum be preserved, or should market competition be promoted. Figure 4-3 explores the RF risks and the benefits of the conflicting policies.

The RF 'environmentalists' preserve the RF spectrum to minimise pollution to other wireless systems. For them, the risk from *spurious emissions* is unacceptable; they enforce restrictions to reduce interference. Consumers should be protected (even from the unregulated and unlicensed Short Range Devices- SRD) and vendors should be managed, in order to conserve the RF resource. Worst-case assumptions about RF interference and risk adversity are essential to optimise the RF use. The classification of countries is carried out according to their self-identification with the intolerant Europe or with the liberal USA, Canada and Japan; their attitude towards the *precautionary principle* (the risk-averse countries implement it by law); whether they take the '*guilty* until proven *innocent*' approach (corresponds to low thresholds permitted), or '*innocent* until proven *guilty*' style; responsibility for the RF pollution (the RF guard-bands are part of the signal); assuming worst case scenario (such as very short distances between the polluting-emitter and the victim-receiver) or the realistic conditions (fit the *laissez-faire* approach). The initial conditions lead to the rational RF limit goal: low or high permitted *spurious emissions.*

Those whose interest lies in financial gain encourage minimum restrictions on RF equipment. The competition (supply and demand), *Homo Œconomicus* and *Caveat Emptor*[29] balance the market; there is no need for administrative 'command and control'; it is a problem between the vendor (to produce non-interfering and immune RF systems) and the client (to choose reliable, robust or cheap products). The cost to society is also of *societal concern*. The injury and risk from liberal *spurious emissions* are tolerable; nevertheless, most of the RF spectrum is unused. The limits are sufficient to protect the licensed networked services (such as broadcasting and cellular). The main *means* of accomplishing business *strategies* and *goals* is to advance tolerable (high in this case) spurious thresholds.

4.3.3 RF Uncertain Risks: Summary

There are two opposing rationalities: *central-based* versus *market-based*. The *hierarchist* and the *egalitarian* are the RF environmentalists; they orient themselves towards a *central-planning* approach that will take into account the *precautionary principle* and reduce RF *human hazards*. A better RF spectrum efficiency is derived from stringent (lower) *spurious emissions,* and is imperative for the collective and the future. In the *individualist* worldview these risks are not a top priority; the market forces should dominate in selecting the thresholds. The EMF from cellular masts and electricity pylons, causing *human hazards,* is not evidently hazardous; technology will solve interference from high *spurious emissions*. Therefore, in this view the *human hazards* and *spurious emissions* thresholds should stay tolerable (high).

[29] 'Buyer beware': in case of interference to the receiver from the *spurious emissions*, the unlucky non-precautious buyer of the receiver may suffer malfunction.

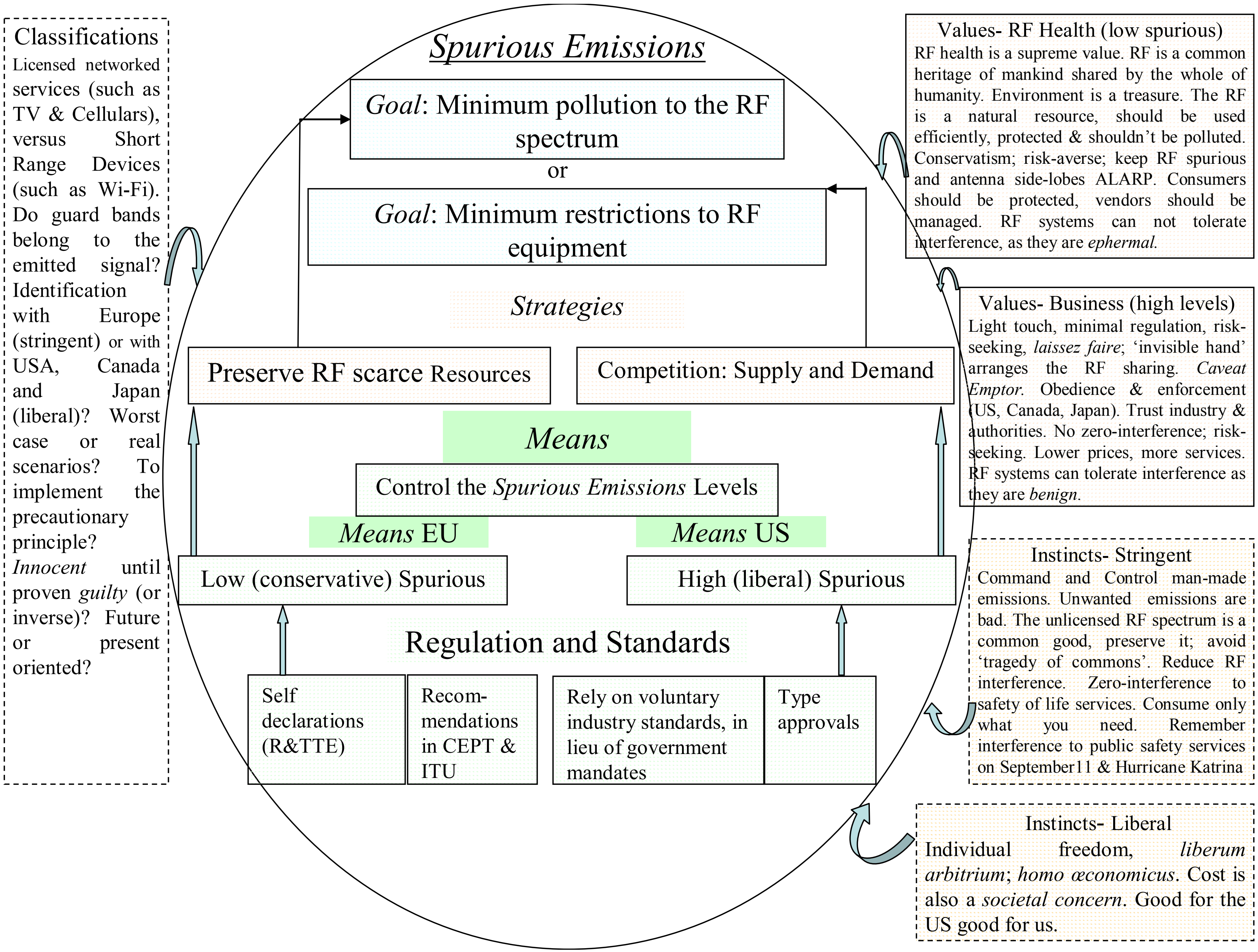

Figure 4-3 RFT template: *spurious emissions* levels

4.4 RFT Summary

Risk management decisions are based on some form of prejudice or preference for one choice over another. RFT aids the process of making rational RF regulatory decisions. This theory analyses three distinctive conflicts focused on the *regulatory frameworks* for wireless communications, *societal and risk concerns*. RFT formulates the complex situation facing wireless regulation and standards; the subjects lie in the heart of regulating uncertain risks. Two discrete choices obligate the national administration to decide, based on political objectives, worldviews and beliefs. RFT reveals the two alternatives for inspection, in the face of convincing arguments. It clarifies that poles-apart *values* guide to opposing *goals*; the RFT templates evaluate the *goals*, and match between these *goals* and surrounding *instincts*, *classifications* and *values*. RFT explores obvious conflicts between *goals*, derived from opposing *values*; therefore, the *instincts*, *strategies* and *means* are contradictory. RFT instructs to take account of the benefits, from the services of general economic interest or equipment causing the risk. The figures in this section have the potential to be transferred to a practical method, a decision-making tool, to be utilised by administrations, service providers, suppliers, local communities, environmentalists and wireless communications consumers (most of us).

In general, ITU-R Region 1 countries follow European regulation, Region 2 follows the USA; Region 3 has no leadership and each state regulator is free to choose which type of regulation he prefers, bounded by culture and geopolitical influence. The policy decision is significant, as it implies the adoption of wireless standards, such as that of TV and cellular equipment. In this thesis RFT analyses and explains the empirical results. The RFT template in Figure 4-1 exposes the *classification* for administrations EU versus US, by geography, culture (language, religion and legal origin), state politics, geopolitical influence and regional membership.

Different worldviews cause opposing regulation of uncertain risks. The thresholds of *human hazards* and *spurious emissions* are typical cases in exploring the human and RF system health. RFT templates explain why different *values* guide to opposite *goals* and *means*. It is difficult to bridge between the far-removed thresholds of *human hazards* or *spurious emissions*; but RFT reveals the roots of the clash.

— On the one hand precaution, prudence, looking at health as a supreme value, future interests, protecting the environment as a treasure, excessive awareness of *societal concerns* and avoiding accusations of being out of touch about safety lead to minimal RF *human hazards* and minimal pollution to the RF spectrum.

— On the other hand prioritising the RF industry, short-term benefits, implementing a *laissez-faire* policy, minimal regulation and practicability result in minimum (and tolerable) restrictions to RF installations and equipment.

In deciding how to handle the *societal* and *risk concerns* of RF in the best interest of society, it is necessary to be aware of the underlying motivations of all stakeholder groups. RFT templates in Figures 4-2 and 4-3 provide a framework to include the *values* of all groups. The same cluster of developed countries select liberal or restrictive thresholds. As worldviews, beliefs and *values* differ by country, it is not surprising that the same countries are risk-seeking (Canada, Japan and USA) in regulating the *human hazards* and the *spurious emissions*. The 'avant-garde' countries (especially US, Canada, UK, Japan, Australia and New Zealand) prioritise business, service carriers and innovative wireless regulation. RFT explains the difference in specific wireless rules through conflicting worldviews and *values*.

A key issue that will always exist is whether the benefits of the low level of *human hazards* or *spurious emissions* outweigh the inevitable burden to business. The answer to this question lies in social *collective values* and not in science or engineering.

RFT exposes assumptions and choices to proper debates. RFT enriches the dialogue and contributes to the quality and meaningfulness of debates, by paying more attention to decision processes, and with what conflicting choices these decisions are actually being made. The RFT template is a suitable tool for exploring specific regulatory objects. RFT explains the empirical results of preceding chapters through worldviews and beliefs. The RFT is more suitable to specific matters, as it is less schematic and general than the *Cultural Theory* and *Bounded Rationality*.

5 Summary: Three Theories Explaining the Findings

This chapter qualifies the findings; it synthesises three cultural theories to analyse, categorise systematically the countries and explain the empirical results. The attitude towards allocation of RF scarce resources and regulating uncertain risks is derived from a social prism. The thesis analyses the rationality in regulating RF and the social response to risk. A multi-disciplinary approach is taken to explain the empirical findings and to demonstrate their connection to culture and geography. The three theories analyse the empirical study, explore the patterns found within the results, and explain the specific rationality in the *regulatory framework* and in adopting RF standards or risk thresholds. The common denominator of the three theories is the regulator's rationality (see *Theories*, figure 4.2); the decision-maker's rationality synthesises the theories, offers theoretical consistency and provides an overarching link between them. Four *Cultural Theory* (CT) rationalities shape the RF *societal and risk concerns*; *Bounded Rationality* (BR) indicates the bounds of rationality in decision-making; *Rational Field Theory* (RFT) guides how to regulate more rationally. CT applies the four typologies of decision-making, and contrasts the *collectivised* and *individualised* rationalities. The BR explains how culture provides the arguments to transform the *objective* (or *substantive*) irrational decisions into a *subjective* (or *procedural*) rationality. The RFT analyses and provides a decision tool for an administration to rationally choose between the European and the US wireless rules and to determine the RF limits of uncertain risks. Wireless regulation and standards have been explained in a broad view of competing theories, emphasising culture, *societal concerns* and risk-taking behaviour. The world and each state are seen to be pluralist societies with different social *values*, worldviews, priorities and aspirations.

A common worldview held by a cluster of countries leads them to adopt a similar wireless *regulatory framework* (*collectivised* or *individualised*), that is, restrictive or liberal thresholds in regulating RF uncertain risks. CT is a general framework for analysing institutional responses to risk; it explains the differences in RF harmonisation, top-down technology and regulating uncertain risks, using the four typical characters identified. Confronting the *egalitarian* and *hierarchist* versus the *individualist* and *fatalist* views elicits the *collectivised central-planning* versus the *individualised market-based* rationalities: a two-fold approach, instead of four-fold. This comparison provides a focused sight to explain the differences in RF allocation and licensing. CT demonstrates **why** the same cluster of *market-based* countries is more tolerable to RF risks (lower thresholds of *human hazards* and *spurious emissions*) and allows for wireless technological innovation (such as RF spectrum trading). BR explains *objective* irrational decisions of state regulators by culture. The *social networks* provide the cultural attributes that bound the rationality of government agencies and decision-makers. The most significant non-rationality is that developing countries invent their own specific regulation and maintain standardisation institutes, even though they do not develop their own wireless equipment. The RFT permits a focus on three major conflicts of wireless regulation. RFT explains the outcomes through different worldviews and beliefs. RFT recognises that *instincts, values* and *classifications* differ according to the specific subject. The EU and US are leading the wireless regulation and standards, the RF networked services and equipment. Countries can adapt these rules and follow the ones most suitable to their country.

A measure of obedience to authority and the *collective values* (*common understanding*, *common knowledge, collective unconscious* and *collective constructs*) are the distinct traits of countries that cause fundamental differences in *societal and risk concerns*; they appear in the three theories. 'Obedient societies' (USA, Canada and Japan) tolerate less restrictive RF thresholds, more power and bandwidths in the public-common RF bands. The *collective values* characterise societies, and categorise them in terms of four typical prototypes, and the *collectivised* or *individualised* rationalities. This approach may direct administrations toward EU or US regulatory styles, and to adopt EU or US standards. The decision-behaviour divides between *hierarchists* and *individualists*; the former choose the preservation of RF spectrum, human and wireless health, while the latter offer precedence to freedom and business. Obedience and *collective values* link the acceptance of authority, loyalty, trust, moral principles and way of thinking about life, to explain wireless regulation and standards. All those attributes are rooted in the nuclear family and are difficult to change.

Geography is the most reasonable and rational attribute to define wireless regulation and standards. Rational RF regulation contributes to the long-term national *goals* of a country, more employment, qualified communication, lower prices, wireless interoperability, and serves the citizen-consumer. The initial assumption is that government agencies may act rationally, in a ‘rational order’, even under uncertainty. The rationale of developed countries is to maximise the benefits of the citizen and the RF consumer. Wireless regulation (like other regulation) is not single-metric rationality nor is it in the incoherence of complete relativism. Risk and uncertainty limit the rationality (Simon 1982:410); type of rationality and *risk tolerability* shape the wireless *regulatory framework*.

The three theories serve theoretical consistency in the thesis: CT interprets the regulator rationality into four and two diverse cultures; BR explains the irrationality as a factor of culture; *rational fields* illustrate the roots of rationality. The three theories contribute to the objectification/rationality *(Versachlichung)* of the risk debate. The CT perceptual filters model, the boundaries of rationality and the *rational fields* suggest that between the multi-rationalities there exists the possibility of constructive dialogue. The wireless *regulatory framework*, *societal and risk concerns* depend on the regulators' rationality. The three theories define a set-up that harnesses why culture and geography explain the RF regulation and standards. The theories illuminate the rationale of the rules from various angles. CT explains the rationality, even if decision-makers are different ('Divided they Stand'); it recognises four types of rationality. The four prototypes provide a sufficient number of rationalities to explain 'all' social interactions; it cannot be said that any particular one is 'right' in the absolute sense, because each has its own logic. Culture bridges the *objective*/ *substantive* irrationality and the *subjective*/ *procedural* rationality; by means of cultural explanations, the decisions become *subjectively* rational. BR indicates the cultural attributes that bound the rationality of administrations. RFT adds worldviews and beliefs to explain why the *collectivised central-planning* administrations are less tolerable to risk and more restrictive in the RF thresholds (*human hazards* and *spurious emissions*), than the *individualised market-based*; the national approach and concern about the environment and health form the RF limits. RFT includes philosophies to strengthen the exploration of the two previous theories. The RFT template separates the problem to its *rational fields*; they illustrate the *values* and *goals* of the two opposite clusters of countries. The research reveals that theoretical tools exploring health promotion, global warming and nuclear plants may also categorise countries, explain the tolerability to RF risk, and are useful in guarding the human and wireless systems' health against RF hazards.

Chapter 7 *Conclusion*

The thesis begins by looking at ITU, EU and *CAN*, emphasising the impact of international/regional regulation on national wireless rules and standards. The regional agencies are compared and contrasted. The *Case Studies* chapter describes the *regulatory frameworks* and attitudes to risk in UK, France, the US and Ecuador. These cases serve as a means for identifying common patterns and roots of *societal concerns* and *risk tolerability*; the ideas of different rationalities are developed from the case studies. The *Indicators* chapter shows the influence of culture and geography on cellular penetration, adopting wireless rules and standards, regulating uncertain risks and managing RF for innovation. The *Indicators* underlines that RF regulation and standards probably follow the post-colonial and geopolitical influence of each particular country. The global spread of the research is significant, of general public interest, descriptive and explanatory worth.

Selected RF data is collected methodologically from qualified case studies and worldwide in order to classify countries and regions. The thesis is concerned about attitudes to risk; the three sociological theories are used to account for RF risk behaviours; the theories shed useful insights. The regulation of uncertain risks and the scarce resource allocation can be explored through cultural prisms. The *International and Regional Frameworks, Case Studies* and *Indicators* chapters primarily set and analyse the data. The theories explain the results, including the exceptional findings, providing them with meaning, and the mechanisms linking them to the theories. Rationality is the common denominator of the three sociological theories; three synthesised theories (see *Theories* chapter, section 5 and figure 4-2) systematically categorise the countries by their different rationalities; the theories consistently interpret the empirical data. The three contending theories underline why cultural and geographic attributes shape the regulation of wireless communications.

This study inquires to what extent certain features of culture and geography influence; demonstrating that culture and geography influence technical rules is original. The empirical data reveals the weight of culture (language, religion and legal origin) and geography (continents, Tropical- non Tropical, North-South, East-West and topography) on RF regulation and standardisation. *Cultural Theory* categorises the national rationalities in terms of perceptual filters; *Bounded Rationality* binds the decision-makers toward a predetermined 'duct' that they find difficult to break away from; the *Rational Field Theory* templates define the national *common understanding* and *collective constructs* guiding the decision-makers.

Based on the comparative study, the research proposes another outlook on the problems associated with the wireless regulatory framework, based on other countries' solutions. The thesis provides the theoretical tools to understand the adoption of wireless standards, and why a cluster of countries might be more risk-seeking in regulating RF uncertainties and managing RF for technological innovation; conclusions are drawn using these new insights.

This thesis is about the ways RF is regulated and standardised, and understanding why; it shows how some methods of RF regulation and standardisation are more appropriate in some places than others. Studying developed and developing countries across different continents provides the foundation for understanding the *regulatory frameworks* in particular countries, international and regional organisations, all over the world. Lessons and ideas can cross the ocean easily, as the RF ether is not related to any national culture per-se: history, tradition, language, religion or legal origin.

Wireless rules indicate how a society functions; RF standards and thresholds reveal the national risk attitude. The research explains how choices are unnecessarily bound by culture; it contrasts rationalities and RF regulation in the European and American hemispheres; the most influential powers in wireless regulation. The cultural attributes are linked to the geopolitical influence (EU versus US), and therefore may explain the wireless technology, regulation and standards. The research about RF allocation illuminates factors which are central to compare the regulation in Europe and the US. The US is the first to approve advanced wireless services (Software Defined Radios, Broadband over Power Lines and Ultra Wide Band), permits more transmission power, in more RF bands with lenient limits. However, the neutral technology in the US enabled the EU to win the cellular market: the GSM technology is operated in practically all countries; far more than the US CDMA. The GSM success opens possibilities outside Europe to other 'parallel' ETSI standards, such as the UMTS and the DVB-T (e.g. Taiwan prefers DVB-T over the American ATSC). The external importance of EU and the US is their influence on the regulation and standardisation of wireless telecommunications outside their own geographical boundaries. The research is carried out on the developing country Ecuador, the Andean Community and South America; it demonstrates the authority of the US and EU rules in South America. The *Indicators* chapter illustrates that cellular and TV standards are clearly separated into two hemispheres: Europe and the US. The worldwide *regulatory framework* of wireless communications, *societal and risk concerns* follow a similar path (EU versus US): *central-planning* (typical to EU, France and Ecuador) and *market-based* (typical to the US) approaches.

The thesis answers the three research questions:

1) *How* and *why* do culture and geography influence RF allocation and licensing?

2) To what extent do sociological theories of risk offer an explanation of the pattern of

allocation of the RF spectrum, including licensing and issues of *risk tolerability*?

3) What are the different *rationalities* in RF allocation and licensing?

Question 1: The *International and Regional Frameworks, Case Studies* and *Indicators* chapters describe **how** culture and geography influence regulation; in the *Discussion* chapter, the three theories explain **why**. The geography is the most evident factor that forms the rational RF regulation; it is simply necessary to follow the ITU Regional RF allocation and regional licensing. Therefore, regional maps illustrate the outlined countries in RF standardisation. Geographical isolation enables the individualist allocation in the US, Canada and Japan. Topography determines the obstacles to the propagation of the radio waves. The geographical latitude determines the elevation angle towards broadcasting satellites; the longitude determines which of those satellites can be received. The latitude governs climate, economic growth and the vitality of wireless communications in long and dark winters (in high latitudes). The tropical climate may create a no-change / stagnation attitude to wireless rules.

Culture defines the *collective values* that form the *social institutions*. The cultural attributes of language, religion and legal origin reveal the colonial heritage and the geopolitical influence. It is difficult to separate their influence, as they are strongly interlinked: e.g. all twenty-one Spanish speaking countries are Catholic and apply the *civil law*. The language provides confidence in adopting standards developed by countries speaking the same language, and enables the citizens to understand in some cases the products (such as Video Home System in the TV set) in their mother tongue. The religion is formed like the language in the nuclear family; it probably defines the standpoint towards the superior, it may shape the perception of risk, the *risk tolerability* (e.g. through the worldview of what is important in life) and the attitude to *central-planning* versus *market-based*; the research could not indicate an impact of religion on adopting wireless standards. The Protestant countries (Australia, Canada, New-Zealand, UK and USA) regulate in an *individualist* rationality: they are more risk-seeking in regulating uncertain risks, and their *market-based* policy promotes innovative wireless regulation. The legal origin formulates the styles of procedural formalism, and interventionism; the *common law* may characterise countries with bureaucratic efficiency.

Question 2: the thesis consistently follows a sociological perspective. The sociological theories *Cultural Theory*, *Bounded Rationality* and *Rational Field Theory* explain the two-fold pattern of RF allocation, the different licensing approaches and analyse the *risk tolerability*. Tables 2-2 and 2-3 in the *Theories* chapter and Figure 2-2 in the *Discussion* chapter, derived from *Cultural Theory*, summarise the differences of the *collectivised* *central-planning* rationality versus the *individualised market-based* approach. The two-fold rationality explains why certain countries are more tolerant in regulating uncertain risks, and thus they tolerate technological innovation; whereas *central-based* states are more cautious and apply the 'precautionary principle'. *Bounded Rationality* highlights *objective* irrational decisions and exceptional wireless standards; there is no need to invent national regulation and RF allocation when administrations can choose the appropriate existing rules. The *Rational Field Theory* justifies the outcomes through different worldviews and cultural beliefs, and templates provide a decision-making and a design tool for regulatory needs. Risk is subjective. The *risk tolerability* is rooted in national *collective values*; such *collective constructs* cluster countries that are more tolerant to RF risks. These *individualist* administrations increase the exposure levels of *human hazards*, permit higher limits of *spurious emissions* and originate innovative wireless regulation.

Question 3: there is no one-absolute truth or one rationality. Multi-rationality fits the distinct *rationalities* in the global RF allocation and licensing. Multicultural and multi-rational views are heeded in decision-making. The priorities of rich and poor countries in tackling RF risks are disparate. The four typological prototypes of the *Cultural Theory* represent the approaches of countries towards the RF *human hazards*, *risk tolerability* and *societal concerns*. The *central-planning* and *market-based* rationalities represent the opposite wireless *regulatory frameworks*, and also reflect the two RF standardisation hemispheres (the EU versus the US). The *Bounded Rationality* divides the rationality itself into *objective* and *subjective* rationalities. This thesis explains the apparent irrational decisions by cultural attributes, including passion. The *Rational Field Theory* enters philosophical values and beliefs in order to explain opposing decisions.

If the mental horizons, self-imposed or externally-imposed boundaries of decision-makers (and what determines them) are understood, then we have the possibility to seize new opportunities. Countries adopt regulation and systems in general, and particularly in e-Communications and in wireless, according to a certain pattern. The adoption of TV and cellular standards, regulating uncertain risks (*human hazards* and *spurious emissions*) and managing RF for innovation reveal this model. The *regulatory framework* of wireless e-Communications is derived from the telecommunications regulatory framework. The thesis does not extend its analysis to a parallel level of regulation (transport, industry, commerce) and similar networked services (roads, electricity, water, gas). It would be interesting to explore how the conclusions might be applied to those areas as well, since the roots of the country's *regulatory framework* are derived from its *collective values*; the spirit of its regulation follows the same cultural and geopolitical factors that form the wireless rules.

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[1] The views or opinions expressed in the research are solely those of the author. The ideas from external experts and observers are not necessarily the official view of the contributor's organisation.

[2] Consultation with experts was done mainly through email correspondence, by asking to comment on ideas. "*" – aurally only.

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Appendix B: *Master-Data* , 235 Countries: Geography, Culture and RF factors

9Jan08	Country & ITU Code		Geography				Member States		Cultural Attributes			General			Geopolitical Influence			RF factors						
units	World Bank names	ITUcode		Decimal	N/ NT	ITU-R			Etntnologue			Hertz	R/L	1/2/3	Regional	Separate Centuries		%Cellulars/inhabitant		Land Mobile				TV
	Country		Continent	Latitude	Tropic	Region	Sovereign	Dominant	Languag	Religion	Law	50/60	Side	Dev	Membership	20th	21st	2003	2006	GSM	CDMA	UMTS	TETRA	ColourTV
1	Afghanistan	AFG	Asia	33.0	NT	3	M	1_1	1_2	MSL	MS	50	R	3	APT	UK	APT	1.0	8.1	1	0	0	0	SECAM
2	Albania	ALB	Europe	41.0	NT	1	M	1_1	1_2	MSL	FRA	50	R	2	CEPT,FRATEL	FRA	EU	35.8	48.9	1	0	0	0	PAL
3	Algeria	ALG	Africa	28.0	NT	1	M	1_1	ARB	MSL	FRA	50	R	2	ATU,CAPTEF,FRATEL	FRA	EU	4.5	63.0	1	1	0	1	PAL
4	American Samoa	SMA	Oceania	14.3	T	3	USA	1_1	1_2	PRT	ENG	60	R	2	None	USA	USA	3.5	3.6	x	x	x	x	NTSC
5	Andorra	AND	Europe	42.5	NT	1	M	1_1	1_2	CTH	FRA	50	R	1	CEPT	FRA	EU	61.6	96.1	1	0	0	0	PAL
6	Angola	AGL	Africa	12.5	T	1	M	1_1	POR	1_2	FRA	50	R	3	ATU,TRASA	POR	EU	2.3	14.3	1	1	0	0	PAL
7	Anguilla	AIA	Americas	18.3	T	2	G	USA	ENG	PRT	ENG	60	L	2	CANTO	UK	EU	x	x	1	0	0	0	NTSC
8	Antigua and Barbuda	ATG	Americas	17.1	T	2	M	USA	ENG	PRT	ENG	60	L	2	CANTO,CITEL,CTO	USA	USA	57.9	x	1	0	0	0	NTSC
9	Argentina	ARG	Americas	34.0	NT	2	M	1_1	SPA	CTH	FRA	50	R	2	CITEL,IIRSA,REGULATEL	USAl	USAl	20.7	80.5	1	1	0	1	PAL
10	Armenia	ARM	Asia	40.0	NT	1	M	1_1	RUS	EST	RUS	50	R	2	RCC,USSR	RUS	RUS	3.0	10.5	1	0	0	0	SECAM^
11	Aruba	ABW	Americas	12.5	T	2	HOL	1_1	NLD	CTH	FRA	60	R	2	CANTO	HOL	EU	72.3	108.8	1	0	0	0	NTSC
12	Australia	AUS	Oceania	27.0	NT	3	M	AUS	ENG	PRT	ENG	50	L	1	APT,CTO	OCN	OCN	72.2	97.0	1	1	1	1	PAL
13	Austria	AUT	Europe	47.3	NT	1	M	1_1	DEU	CTH	DEU	50	R	1	CEPT,EU	DEU	EU	87.2	112.8	1	0	1	1	PAL
14	Azerbaijan	AZE	Asia	40.5	NT	1	M	1_1	RUS	MSL	RUS	50	R	2	CEPT,RCC,USSR	RUS	RUS	12.8	39.2	1	1	0	1	SECAM
15	Bahamas	BAH	Americas	24.3	NT	2	M	USA	ENG	PRT	ENG	60	L	2	CANTO,CITEL,CTO	USA	USA	36.7	70.5	1	1	0	0	NTSC
16	Bahrain	BHR	Asia	26.0	NT	1	M	1_1	ARB	MSL	ENG	50	R	2	ARBl	UK	ARB	63.8	121.7	1	0	1	1	PAL
17	Bangladesh	BGD	Asia	24.0	NT	3	M	1_1	1_2	MSL	ENG	50	L	3	APT,CTO	UK	APT	1.0	13.3	1	1	0	0	PAL
18	Barbados	BRB	Americas	13.2	T	2	M	USA	ENG	PRT	ENG	50	L	2	CANTO,CITEL,CTO	USA	USA	51.9	76.7	1	1	0	0	NTSC
19	Belarus	BLR	Europe	53.0	NT	1	M	1_1	RUS	EST	RUS	50	R	2	CEPT,RCC,USSR	RUS	RUS	11.3	61.4	1	1	0	1	SECAM
20	Belgium	BEL	Europe	50.8	NT	1	M	1_1	1_2	CTH	FRA	50	R	1	CEPT,EU,FRATEL	HOL	EU	83.0	92.6	1	0	1	1	PAL
21	Belize	BLZ	Americas	17.3	T	2	M	1_1	ENG	CTH	ENG	60	R	2	CANTO,CITEL,CTO	USA	USA	23.2	43.0	1	1	0	0	NTSC
22	Benin	BEN	Africa	9.5	T	1	M	1_1	FRA	1_2	FRA	50	R	3	ATU,CAPTEF,ECOWAS,FRA	FRA	EU	3.4	12.1	1	0	0	0	SECAM
23	Bermuda	BER	Americas	32.3	NT	2	G	USA	ENG	PRT	ENG	60	L	3	None	USA	USA	61.2	x	1	1	0	0	NTSC
24	Bhutan	BTN	Asia	27.5	NT	3	M	1_1	1_2	BDH	ENG	50	L	2	APT	UK	APT	1.1	x	1	0	0	0	PAL

	Country		Continent	Latitude	Tropic	Region	Sovereign	Dominant	Languag	Religion	Law	50/60	Side	Dev	Membership	20th	21st	2003	2006	GSM	CDMA	UMTS	TETRA	ColourTV
25	Bolivia	BOL	Americas	17.0	T	2	M	1_1	SPA	CTH	FRA	50	R	2	CAATEL,CITEL,IIRSA,REGU	USAl	USAl	15.2	28.9	1	0	0	0	NTSC
26	Bosnia&Herzegovina	BIH	Europe	44.0	NT	1	M	1_1	1_2	MSL	DEU	50	R	2	CEPT	EEC	EU	27.4	48.3	1	0	0	0	PAL
27	Botswana	BOT	Africa	22.0	T	1	M	1_1	ENG	1_2	ENG	50	L	2	CTO,TRASA	UK	EU	29.7	55.7	1	1	0	0	PAL
28	Brazil	B1	Americas	10.0	T	2	M	1_1	POR	CTH	FRA	60	R	2	CITEL,IIRSA,Mercosur,REGU	USAl	USAl	26.3	52.9	1	1	0	1	PAL
29	British Virgin Isla	VRG	Americas	18.5	T	2	G	USA	ENG	PRT	ENG	x	L	2	None	UK	EU	x	x	1	0	0	0	NTSC
30	Brunei Darussalam	BRU	Asia	4.5	T	3	M	1_1	1_2	MSL	ENG	50	L	2	APT,CTO	UK	EU	50.7	66.5	1	0	1	1	PAL
31	Bulgaria	BUL	Europe	43.0	NT	1	M	1_1	1_2	EST	RUS	50	R	2	CEPT,EU,FRATEL	EEC	EU	44.9	107.6	1	0	0	1	SECAM^
32	Burkina Faso	BFA	Africa	13.0	T	1	M	1_1	FRA	1_2	FRA	50	R	3	ATU,CAPTEF,ECOWAS,FRA	FRA	EU	1.9	7.5	1	0	0	0	SECAM
33	Burundi	BDI	Africa	22.0	T	1	M	1_1	1_2	CTH	FRA	50	R	3	ATU,CAPTEF,FRATEL	FRA	EU	0.9	2.0	1	0	0	0	SECAM
34	Cambodia	CBG	Asia	13.0	T	3	M	1_1	1_2	BDH	FRA	50	R	3	FRATEL	FRA	EU	3.5	7.9	1	1	0	0	PAL
35	Cameroon	CME	Africa	6.0	T	1	M	1_1	FRA	1_2	FRA	50	R	2	ATU,CTO,FRATEL	UK	EU	6.6	13.8	1	1	0	0	PAL
36	Canada	CAN	Americas	60.0	NT	2	M	USA	ENG	CTH	ENG	60	R	1	CITEL,CTO,FRATEL,NAFTA	USA	USA	41.7	52.5	1	1	0	0	NTSC
37	Cape Verde	CPV	Africa	16.0	T	1	M	1_1	POR	CTH	FRA	50	R	3	FRATEL,ECOWAS	FRA	EU	11.6	21.0	1	0	0	0	SECAM
38	Cayman Islands	CYM	Americas	19.5	T	2	G	USA	ENG	PRT	ENG	60	L	1	CANTO	USA	USA	48.8	76.6	1	1	0	0	NTSC
39	Central African Rep	CAF	Africa	7.0	T	1	M	1_1	FRA	1_2	FRA	50	R	3	ATU,CAPTEF,FRATEL	FRA	EU	1.0	2.5	1	0	0	0	SECAM
40	Chad	TCD	Africa	15.0	T	1	M	1_1	FRA	MSL	FRA	50	R	3	ATU,CAPTEF,FRATEL	FRA	EU	0.8	4.7	1	0	0	0	SECAM
41	Chile	CHL	Americas	30.0	NT	2	M	1_1	SPA	CTH	FRA	50	R	2	CITEL,IIRSA,REGULATEL	USAl	USAl	49.4	75.6	1	1	0	1	NTSC
42	China	CHN	Asia	35.0	NT	3	M	1_1	CHN	BDH	RUS	50	R	2	APT	**CHN**	**CHN**	20.9	34.8	1	1	0	1	PAL
43	Christmas Island	CHR	Asia	10.5	T	3	AUS	AUS	ENG	BDH	ENG	50	L	x	None	OCN	OCN	x	x	1	0	0	0	PAL
44	Cocos (Keeling) I:	CCK	Asia	12.5	T	3	AUS	AUS	1_2	MSL	ENG	x	L	x	None	OCN	OCN	x	x	x	x	x	x	PAL
45	Colombia	CLM	Americas	4.0	T	2	M	1_1	SPA	CTH	FRA	60	R	2	CAATEL,CITEL,IIRSA,REGU	USAl	USAl	14.1	64.3	1	1	0	0	NTSC
46	Comoros	COM	Africa	12.2	T	1	M	FRA	ARB	MSL	FRA	50	R	3	ARBl,ATU,CAPTEF,FRATEL	FRA	EU	0.3	2.0	1	0	0	0	SECAM
47	Congo	COG	Africa	0.0	T	1	M	1_1	FRA	CTH	FRA	50	R	2	ATU,CAPTEF	FRA	EU	9.4	12.3	1	0	0	1	SECAM
48	Congo, Democratic	COD	Africa	1.0	T	1	M	1_1	FRA	CTH	FRA	50	R	3	ATU,CAPTEF,FRATEL,TRAS	FRA	EU	2.3	7.4	1	1	0	0	SECAM
49	Cook Islands	CKH	Oceania	21.2	T	3	NZL	1_1	ENG	PRT	ENG	50	L	2	APT	OCN	OCN	x	x	1	0	0	0	PAL
50	Costa Rica	CTR	Americas	10.0	T	2	M	1_1	SPA	CTH	FRA	60	R	2	CITEL,REGULATEL	USAl	USAl	18.7	32.8	1	0	0	0	NTSC
51	Cote d'Ivoire	CTI	Africa	8.0	T	1	M	1_1	FRA	MSL	FRA	50	R	2	ATU,CAPTEF,ECOWAS,FRA	FRA	EU	7.7	22.0	1	1	0	0	SECAM
52	Croatia	HRV	Europe	45.2	NT	1	M	1_1	1_2	CTH	RUS	50	R	2	CEPT	EEC	EU	58.4	98.1	1	0	1	1	PAL

	Country		Continent	Latitude	Tropic	Region	Sovereign	Dominant	Languag	Religion	Law	50/60	Side	Dev	Membership	20th	21st	2003	2006	GSM	CDMA	UMTS	TETRA	ColourTV
53	Cuba	CUB	Americas	21.5	T	2	M	1_1	SPA	CTH	FRA	60	R	2	CANTO,CITEL,REGULATEL	USAl	USAl	0.3	1.4	1	0	0	0	NTSC
54	Cyprus	CYP	Europe	35.0	NT	1	M	1_1	1_2	EST	ENG	50	L	2	CEPT,CTO,EU	UK	EU	76.8	92.1	1	0	1	0	PAL
55	Czech Republic	CZE	Europe	49.8	NT	1	M	1_1	1_2	CTH	RUS	50	R	2	CEPT,EU,FRATEL	EEC	EU	96.5	119.0	1	1	1	1	SECAM^
56	Denmark	DNK	Europe	56.0	NT	1	M	1_1	1_2	PRT	NRD	50	R	1	CEPT,EU	**DNK**	EU	88.3	107.3	1	1	1	1	PAL
57	Djibouti	DJI	Africa	11.5	T	1	M	1_1	ARB	MSL	FRA	50	R	3	ATU,ARBl,CAPTEF,FRATEL	FRA	EU	3.4	6.4	1	0	0	0	SECAM
58	Dominica	DMA	Americas	15.4	T	2	M	USA	ENG	CTH	ENG	50	L	2	CANTO,CITEL,CTO,FRATEL	USA	USA	27.0	58.7	1	0	0	0	NTSC
59	Dominican Repub	DOM	Americas	19.0	T	2	M	USA	SPA	CTH	FRA	60	R	2	CANTO,CITEL,REGULATEL	USA	USA	24.5	51.1	1	1	0	0	NTSC
60	East Timor	TLS	Asia	8.8	T	3	TLS	1_1	1_2	CTH	FRA	50	L	3	None	OCN	OCN	2.4	4.9	1	0	0	1	PAL
61	Ecuador	EQA	Americas	2.0	T	2	M	1_1	SPA	CTH	FRA	60	R	2	CAATEL,CITEL,IIRSA,REGU	USAl	USAl	18.3	63.2	1	1	0	1	NTSC
62	Egypt	EGY	Africa	27.0	NT	1	M	1_1	ARB	MSL	FRA	50	R	2	ATU,ARBl,FRATEL	FRA	EU	8.4	23.9	1	1	0	1	SECAM^
63	El Salvador	SLV	Americas	13.8	T	2	M	1_1	SPA	CTH	FRA	60	R	2	CITEL,REGULATEL	USAl	USAl	17.3	55.0	1	1	0	0	NTSC
64	Equatorial Guinea	GNE	Africa	2.0	T	1	M	1_1	SPA	CTH	FRA	50	R	3	ATU,FRATEL	UK	EU	7.6	19.3	1	0	0	0	PAL
65	Eritrea	ERI	Africa	15.0	T	1	M	1_1	1_2	MSL	ENG	50	R	3	None	ARB	ARB	0.0	1.4	1	0	0	0	PAL
66	Estonia	EST	Europe	59.0	NT	1	M	1_1	1_2	PRT	RUS	50	R	2	CEPT,EU,USSR	RUS	EU	77.7	125.2	1	0	1	0	SECAM^
67	Ethiopia	ETH	Africa	8.0	T	1	M	1_1	1_2	MSL	ENG	50	R	3	ATU	UK	EU	0.1	1.1	1	1	0	0	PAL
68	Falkland Islands (	FLK	Americas	51.8	NT	2	G	1_1	ENG	PRT	ENG	50	L	1	None	UK	EU	x	x	1	0	x	1	PAL
69	Faroe Islands	FRO	Europe	62.0	NT	1	DNK	1_1	1_2	PRT	NRD	50	R	1	None	DNK	EU	76.5	x	1	0	0	x	PAL
70	Fiji	FJI	Oceania	18.0	T	3	M	1_1	ENG	PRT	ENG	50	L	2	APT,CTO	UK	EU	13.3	24.2	1	1	0	0	PAL
71	Finland	FIN	Europe	64.0	NT	1	M	1_1	1_2	PRT	NRD	50	R	1	CEPT,EU	UK	EU	91.0	107.8	1	1	1	1	PAL
72	France	F	Europe	46.0	NT	1	M	1_1	FRA	CTH	FRA	50	R	1	CAPTEF,CEPT,EU,FRATEL	**FRA**	EU	69.6	85.1	1	0	1	1	SECAM
73	French Guiana	GUF	Americas	4.0	T	2	F	1_1	FRA	CTH	FRA	50	R	2	None	FRA	EU	18.4	x	1	0	0	0	SECAM
74	French Polynesia	OCE	Oceania	15.0	T	3	F	1_1	FRA	PRT	FRA	x	R	1	FRATEL	FRA	EU	24.1	58.5	1	0	0	0	SECAM
75	Gabon	GAB	Africa	1.0	T	1	M	1_1	FRA	CTH	FRA	50	R	2	ATU,CAPTEF,FRATEL	FRA	EU	22.4	54.4	1	0	0	0	SECAM
76	Gambia	GMB	Africa	13.5	T	1	M	1_1	ENG	MSL	ENG	50	R	3	ATU,CTO,ECOWAS	UK	EU	10.9	26.0	1	0	0	0	PAL
77	Georgia	GEO	Europe	42.0	NT	1	M	1_1	RUS	EST	RUS	50	R	2	RCC,USSR	RUS	RUS	14.5	38.4	1	1	0	1	SECAM
78	Germany	D	Europe	51.0	NT	1	M	1_1	DEU	PRT	DEU	50	R	1	CEPT,EU	**DEU**	EU	78.5	101.9	1	0	1	1	PAL
79	Ghana	GHA	Africa	8.0	T	1	M	1_1	ENG	CTH	ENG	50	R	2	ATU,CTO,ECOWAS	UK	EU	3.7	23.1	1	1	0	0	PAL
80	Gibraltar	GIB	Europe	36.1	NT	1	G	1_1	ENG	CTH	ENG	50	R	1	None	UK	EU	55.8	x	1	0	0	1	PAL

	Country		Continent	Latitude	Tropic	Region	Sovereign	Dominant	Languag	Religion	Law	50/60	Side	Dev	Membership	20th	21st	2003	2006	GSM	CDMA	UMTS	TETRA	ColourTV
81	Greece	GRC	Europe	39.0	NT	1	M	1_1	1_2	EST	FRA	50	R	1	CEPT,EU	UK	EU	90.2	99.6	1	0	1	1	SECAM
82	Greenland	GRL	Europe	72.0	NT	2	DNK	1_1	1_2	PRT	NRD	50	R	1	None	DNK	EU	x	x	1	0	0	0	PAL
83	Grenada	GRD	Americas	12.1	T	2	M	USA	ENG	CTH	ENG	50	L	2	CANTO,CITEL,CTO	USA	USA	37.6	x	1	0	0	0	NTSC
84	Guadeloupe	GDL	Americas	16.3	T	2	F	1_1	FRA	CTH	FRA	50	R	2	CANTO	FRA	EU	65.8	x	1	0	0	0	SECAM
85	Guam	GUM	Oceania	13.5	T	3	USA	USA	ENG	CTH	ENG	60	R	2	None	USA	USA	49.3	59.4	1	1	0	0	NTSC
86	Guatemala	GTM	Americas	15.5	T	2	M	1_1	SPA	CTH	FRA	60	R	2	CITEL,REGULATEL	USA	USAl	16.5	55.6	1	1	0	0	NTSC
87	Guernsey	AAA	Europe	49.5	NT	1	G	x	ENG	PRT	ENG	50	L	1	None	UK	EU	74.4	x	1	0	1	x	PAL
88	Guinea	GUI	Africa	11.0	T	1	M	1_1	FRA	MSL	FRA	50	R	3	ATU,CAPTEF,ECOWAS,FRA	FRA	EU	1.4	2.4	1	0	0	0	SECAM^
89	Guinea-Bissau	GNB	Africa	12.0	T	1	M	1_1	POR	1_2	x	50	R	3	ATU,FRATEL,ECOWAS	POR	EU	0.1	7.1	1	0	0	0	PAL
90	Guyana	GUY	Americas	5.0	T	2	M	1_1	ENG	CTH	ENG	60	L	2	CANTO,CITEL,CTO,IIRSA	USA	USA	9.0	37.5	1	0	0	0	NTSC
91	Haiti	HTI	Americas	19.0	T	2	M	1_1	FRA	CTH	FRA	60	R	3	CANTO,CITEL,FRATEL	USA	USA	3.8	5.9	1	1	0	1	SECAM^
92	Honduras	HND	Americas	15.0	T	2	M	1_1	SPA	CTH	FRA	60	R	2	CITEL,REGULATEL	USAl	USAl	5.6	30.4	1	1	0	0	NTSC
93	Hong Kong	HKG	Asia	22.3	T	3	CHN	1_1	CHN	BDH	ENG	50	L	1	APT	UK	CHN	107.9	131.5	1	1	1	1	PAL
94	Hungary	HNG	Europe	47.0	NT	1	M	1_1	1_2	CTH	RUS	50	R	2	CEPT,EU	EEC	EU	78.5	99.0	1	0	1	0	SECAM^
95	Iceland	ISL	Europe	65.0	NT	1	M	1_1	1_2	PRT	NRD	50	R	1	CEPT,EFTA	UK	EU	96.8	110.6	1	0	0	1	PAL
96	India	IND	Asia	20.0	T	3	M	1_1	1_2	HND	ENG	50	L	2	APT,CTO	UK	APT	2.5	14.8	1	1	0	1	PAL
97	Indonesia	INS	Asia	5.0	T	3	M	1_1	1_2	MSL	FRA	50	L	2	APT	UK	APT	8.7	28.3	1	1	1	1	PAL
98	Iran	IRN	Asia	32.0	NT	3	M	1_1	1_2	MSL	MS	50	R	2	APT	1_2	APT	5.1	19.4	1	0	0	1	SECAM^
99	Iraq	IRQ	Asia	33.0	NT	1	M	1_1	ARB	MSL	MS	50	R	2	ARBl	ARB	ARB	0.3	2.2	1	0	0	1	SECAM
100	Ireland	IRL	Europe	53.0	NT	1	M	1_1	ENG	CTH	ENG	50	L	1	CEPT,EU	UK	EU	88.0	111.4	1	1	1	1	PAL
101	Israel	ISR	Asia	31.5	NT	1	M	1_1	1_2	1_2	ENG	50	R	1	None	UK	EU	96.1	122.7	1	1	1	1	PAL
102	Italy	I	Europe	42.8	NT	1	M	1_1	ITA	CTH	FRA	50	R	1	CEPT,EU	ITA	EU	98.1	123.1	1	0	1	1	PAL
103	Jamaica	JMC	Americas	18.3	T	2	M	USA	ENG	PRT	ENG	50	L	2	CANTO,CITEL,CTO	USA	USA	60.6	105.8	1	1	0	0	NTSC
104	Japan	J	Asia	36.0	NT	3	M	1_1	1_2	BDH	DEU	60	L	1	APT	1_2	APT	67.9	79.3	0	1	1	0	NTSC
105	Jersey	JBG	Europe	49.3	NT	1	G	x	ENG	PRT	ENG	50	L	1	None	UK	EU	92.3	x	1	0	0	x	PAL
106	Jordan	JOR	Asia	31.0	NT	1	M	1_1	ARB	MSL	FRA	50	R	2	ARBl	UK	EU	24.2	74.4	1	0	0	0	PAL
107	Kazakhstan	KAZ	Asia	48.0	NT	1	M	RUS	RUS	MSL	RUS	50	R	2	RCC,USSR	RUS	RUS	8.4	52.9	1	1	0	1	SECAM
108	Kenya	KEN	Africa	1.0	T	1	M	1_1	ENG	PRT	ENG	50	L	2	ATU,CTO	UK	EU	5.0	18.5	1	1	0	1	PAL

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109	Kiribati	KIR	Oceania	1.4	T	3	M	1_1	1_2	CTH	x	50	L	3	CTO	UK	EU	0.6	0.7	1	0	0	0	No TV
110	Korea, North	KRE	Asia	40.0	NT	3	M	1_1	1_2	BDH	DEU	50	R	2	APT	1_2	APT	x	x	1	0	0	0	SECAM
111	Korea, South	KOR	Asia	37.0	NT	3	M	1_1	1_2	1_2	DEU	60	R	1	APT	USA	USA	70.2	83.8	1	1	1	1	NTSC
112	Kuwait	KWT	Asia	29.5	NT	1	M	1_1	ARB	MSL	FRA	50	R	2	ARBl	UK	ARB	57.2	88.6	1	1	0	1	PAL
113	Kyrgyzstan	KGZ	Asia	41.0	NT	1	M	1_1	RUS	MSL	RUS	50	R	2	RCC,USSR	RUS	RUS	2.7	10.3	1	1	0	0	SECAM
114	Laos	LAO	Asia	18.0	T	3	M	1_1	1_2	BDH	FRA	50	R	3	FRATEL,APT	FRA	EU	2.0	10.8	1	1	0	0	PAL
115	Latvia	LVA	Europe	57.0	NT	1	M	1_1	1_2	PRT	RUS	50	R	2	CEPT,EU,USSR	RUS	EU	52.6	95.1	1	1	0	1	SECAM^
116	Lebanon	LBN	Asia	33.8	NT	1	M	1_1	ARB	MSL	FRA	50	R	2	ARBl,FRATEL	FRA	EU	23.4	30.5	1	0	0	1	SECAM^
117	Lesotho	LSO	Africa	29.5	NT	1	M	1_1	ENG	CTH	ENG	50	L	3	ATU,CTO,TRASA	UK	EU	4.7	13.9	1	0	0	0	PAL
118	Liberia	LBR	Africa	6.5	T	1	M	1_1	ENG	1_2	ENG	60	R	3	ATU,ECOWAS	UK	EU	1.4	4.9	1	0	0	0	PAL
119	Libya	LBY	Africa	25.0	NT	1	M	1_1	ARB	MSL	MS	50	R	2	ARBl,ATU	ARB	ARB	2.3	65.8	1	0	0	1	SECAM^
120	Liechtenstein	LIE	Europe	47.3	NT	1	M	1_1	DEU	CTH	DEU	50	R	1	CEPT,EFTA	DEU	EU	72.9	x	1	0	0	0	PAL
121	Lithuania	LTU	Europe	56.0	NT	1	M	1_1	1_2	CTH	RUS	50	R	2	CEPT,EU,FRATEL,USSR	RUS	EU	62.8	138.1	1	0	0	0	SECAM^
122	Luxembourg	LUX	Europe	49.8	NT	1	M	1_1	FRA	CTH	FRA	50	R	1	CEPT,EU,FRATEL	DEU	EU	119.4	151.6	1	0	1	1	SECAM^
123	Macao	MAC	Asia	22.2	T	3	CHN	1_1	POR	BDH	FRA	50	L	1	APT	CHN	CHN	81.2	137.4	1	0	0	0	PAL
124	Macedonia	MKD	Europe	41.8	NT	1	M	1_1	1_2	EST	DEU	50	R	2	CEPT	EEC	EU	37.2	69.6	1	0	0	1	PAL
125	Madagascar	MDG	Africa	20.0	T	1	M	1_1	FRA	1_2	FRA	50	R	3	ATU,CAPTEF,FRATEL	FRA	EU	1.7	5.5	1	1	0	0	SECAM
126	Malawi	MWI	Africa	13.5	T	1	M	1_1	ENG	PRT	ENG	50	L	3	ATU,CTO,TRASA	UK	EU	1.3	3.3	1	0	0	0	PAL
127	Malaysia	MLA	Asia	2.5	T	3	M	1_1	1_2	MSL	ENG	50	L	2	APT,CTO	UK	APT	44.4	75.5	1	1	1	1	PAL
128	Maldives	MLD	Asia	3.3	T	3	M	1_1	1_2	MSL	MS	50	L	3	APT,CTO	UK	APT	23.2	87.9	1	0	0	0	PAL
129	Mali	MLI	Africa	17.0	T	1	M	1_1	FRA	MSL	FRA	50	R	3	ATU,CAPTEF,ECOWAS,FRA	FRA	EU	2.3	10.9	1	1	0	0	SECAM
130	Malta	MLT	Europe	35.8	NT	1	M	1_1	1_2	CTH	FRA	50	L	2	CEPT,CTO,EU	UK	EU	72.5	86.0	1	0	0	1	PAL
131	Man, Isle of	IMY	Europe	54.3	NT	1	G	x	ENG	PRT	ENG	50	L	1	None	UK	EU	x	x	1	0	0	x	PAL
132	Marshall Islands	MHL	Oceania	9.0	T	3	M	1_1	ENG	PRT	ENG	60	R	2	APT	USA	USA	1.1	1.1	x	0	0	0	NTSC
133	Martinique	MRT	Americas	14.7	T	2	F	1_1	FRA	CTH	FRA	50	R	1	None	FRA	EU	70.8	x	1	0	0	0	SECAM
134	Mauritania	MTN	Africa	20.0	T	1	M	1_1	ARB	MSL	FRA	50	R	3	ARBl,ATU,CAPTEF,FRATEL	FRA	EU	12.8	33.6	1	0	0	0	SECAM
135	Mauritius	MAU	Africa	20.3	T	1	M	1_1	ENG	HND	FRA	50	L	2	ATU,CTO,FRATEL,TRASA	FRA	EU	26.7	61.5	1	1	1	0	SECAM
136	Mayotte	MYT	Africa	12.8	T	1	F	FRA	1_2	MSL	FRA	50	R	2	None	FRA	EU	19.9	28.8	1	0	0	0	SECAM

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137	Mexico	MEX	Americas	23.0	T	2	M	1_1	SPA	CTH	FRA	60	R	2	CITEL,REGULATEL,NAFTA	USA	USA	29.5	52.6	1	1	0	1	NTSC
138	Micronesia, Feder	FSM	Asia	6.9	T	3	M	1_1	ENG	CTH	ENG	60	R	2	APT	USA	USA	5.4	12.7	1	0	0	0	NTSC
139	Moldova	MDA	Europe	47.0	NT	1	M	1_1	RUS	EST	RUS	50	R	2	CEPT,FRATEL,RCC,USSR	EEC	RUS	13.2	32.4	1	1	0	0	SECAM
140	Monaco	MCO	Europe	43.7	NT	1	M	1_1	FRA	CTH	FRA	50	R	1	CEPT,FRATEL	FRA	EU	43.7	48.8	1	0	0	1	SECAM
141	Mongolia	MNG	Asia	46.0	NT	1	M	1_1	RUS	BDH	RUS	50	R	2	APT	CHN	CHN	13.0	21.1	1	1	0	0	SECAM
142	Montenegro	MNE	Europe	42.3	NT	1	M	1_1	1_2	EST	DEU	50	R	2	CEPT	EEC	EU	33.8	7.8	1	0	0	0	PAL
143	Montserrat	MSR	Americas	16.8	T	2	G	USA	ENG	PRT	ENG	60	L	2	CANTO	UK	EU	x	x	1	0	0	0	NTSC
144	Morocco	MRC	Africa	32.0	NT	1	M	1_1	ARB	MSL	FRA	50	R	2	ARBl,ATU,CAPTEF,FRATEL	FRA	EU	24.4	52.1	1	0	0	1	SECAM
145	Mozambique	MOZ	Africa	18.3	T	1	M	1_1	1_2	1_2	FRA	50	L	3	CTO,TRASA	UK	EU	2.4	11.6	1	1	0	0	PAL
146	Myanmar	BRM	Asia	22.0	T	3	M	1_1	1_2	BDH	x	50	R	3	APT	UK	APT	0.1	0.4	1	1	0	0	NTSC
147	Namibia	NMB	Africa	22.0	T	1	M	1_1	ENG	PRT	ENG	50	L	2	CTO,TRASA	UK	EU	11.6	24.4	1	1	0	0	PAL
148	Nauru	NRU	Oceania	0.5	T	3	M	1_1	1_2	PRT	ENG	50	L	2	APT,CTO	UK	APT	13.0	x	0	0	0	0	PAL
149	Nepal	NPL	Asia	28.0	NT	3	M	1_1	1_2	HND	ENG	50	L	3	APT	UK	APT	0.3	3.8	1	1	0	0	PAL
150	Netherlands	HOL	Europe	52.5	NT	1	M	1_1	NLD	CTH	FRA	50	R	1	CEPT,EU	**HOL**	EU	82.8	97.2	1	0	1	1	PAL
151	Netherlands Antilles	ATN	Americas	12.3	T	2	HOL	1_1	NLD	CTH	FRA	50	R	1	None	HOL	EU	89.9	90.1	1	1	0	0	NTSC
152	New Caledonia	NCL	Oceania	21.5	T	3	F	1_1	FRA	CTH	FRA	50	R	1	FRATEL	FRA	EU	42.4	56.7	1	0	0	0	SECAM
153	New Zealand	NZL	Oceania	41.0	NT	3	M	1_1	ENG	PRT	ENG	50	L	1	APT,CTO	OCN	OCN	64.8	87.6	1	1	1	0	PAL
154	Nicaragua	NCG	Americas	13.0	T	2	M	1_1	SPA	CTH	FRA	60	R	2	CITEL,REGULATEL	USAl	USAl	8.5	32.7	1	1	0	0	NTSC
155	Niger	NGR	Africa	16.0	T	1	M	1_1	FRA	MSL	FRA	50	R	3	ATU,CAPTEF,ECOWAS,FRA	FRA	EU	0.6	2.3	1	1	0	0	SECAM
156	Nigeria	NIG	Africa	10.0	T	1	M	1_1	ENG	MSL	ENG	50	R	2	ATU,CTO,ECOWAS	UK	EU	2.6	24.1	1	1	0	1	PAL
157	Niue	NIU	Oceania	19.0	T	3	NZL	1_1	ENG	PRT	ENG	x	L	2	APT	OCN	OCN	x	x	0	0	0	0	PAL
158	Norfolk Island	NFK	Oceania	29.0	NT	3	AUS	AUS	ENG	PRT	ENG	x	L	x	None	OCN	OCN	x	27.3	1	0	0	0	PAL
159	Northern Marianas	MRA	Oceania	15.2	T	3	USA	USA	ENG	CTH	ENG	60	R	2	None	USA	USA	25.5	x	1	0	0	0	NTSC
160	Norway	NOR	Europe	62.0	NT	1	M	1_1	1_2	PRT	NRD	50	R	1	CEPT,EFTA	UK	EU	90.9	108.6	1	1	1	1	PAL
161	Oman	OMA	Asia	21.0	T	1	M	1_1	ARB	MSL	FRA	50	R	2	ARBl	UK	ARB	22.8	69.6	1	1	0	1	PAL
162	Pakistan	PAK	Asia	30.0	NT	3	M	1_1	1_2	MSL	ENG	50	L	2	APT,CTO	UK	APT	1.6	22.0	1	1	0	0	PAL
163	Palau	PLW	Oceania	7.5	T	3	PLW	1_1	ENG	CTH	ENG	x	R	2	APT	USA	USA	x	x	1	0	0	1	NTSC
164	Panama	PNR	Americas	9.0	T	2	M	1_1	SPA	CTH	FRA	60	R	2	CITEL,REGULATEL	USAl	USAl	26.8	52.5	1	1	0	1	NTSC

	Country		Continent	Latitude	Tropic	Region	Sovereign	Dominant	Languag	Religion	Law	50/60	Side	Dev	Membership	20th	21st	2003	2006	GSM	CDMA	UMTS	TETRA	ColourTV
165	Papua New Guinea	PNG	Oceania	6.0	T	3	M	1_1	1_2	CTH	ENG	50	L	2	APT,CTO	OCN	OCN	0.3	1.3	1	0	0	0	PAL
166	Paraguay	PRG	Americas	23.0	T	2	M	1_1	SPA	CTH	FRA	50	R	2	CITEL,IIRSA,Mercosur,REGU	USAl	USAl	29.9	51.3	1	0	0	0	PAL
167	Peru	PRU	Americas	10.0	T	2	M	1_1	SPA	CTH	FRA	60	R	2	CAATEL,CITEL,IIRSA,REGU	USAl	USAl	10.7	30.0	1	1	0	1	NTSC
168	Philippines	PHL	Asia	13.0	T	3	M	1_1	1_2	CTH	FRA	60	R	2	APT	USA	USA	27.8	50.8	1	1	0	0	NTSC
169	Pitcairn	PTC	Oceania	25.1	NT	3	G	x	ENG	PRT	ENG	x	L	x	None	UK	EU	x	x	x	0	0	0	No TV
170	Poland	POL	Europe	52.0	NT	1	M	1_1	1_2	CTH	RUS	50	R	2	CEPT,EU,FRATEL	EEC	EU	45.1	95.5	1	1	1	1	SECAM^
171	Portugal	POR	Europe	39.5	NT	1	M	1_1	POR	CTH	FRA	50	R	1	CEPT,EU	POR	EU	95.8	116.0	1	1	1	1	PAL
172	Puerto Rico	PTR	Americas	18.3	T	2	USA	USA	SPA	CTH	FRA	60	R	2	None	USAl	USAl	48.0	84.8	1	1	0	0	NTSC
173	Qatar	QAT	Asia	25.5	NT	1	M	1_1	ARB	MSL	MS	50	R	2	ARBl	UK	ARB	53.3	109.6	1	0	0	1	PAL
174	Reunion	REU	Africa	21.1	T	1	F	1_1	FRA	CTH	FRA	50	R	1	None	FRA	EU	69.0		1	0	0	0	SECAM
175	Romania	ROU	Europe	46.0	NT	1	M	1_1	1_2	EST	RUS	50	R	2	CEPT,EU,FRATEL	EEC	EU	32.5	80.5	1	1	1	1	PAL
176	Russia	RUS	Europe	60.0	NT	1	M	RUS	RUS	EST	RUS	50	R	2	CEPT,RCC,USSR	RUS	RUS	24.9	83.6	1	1	0	1	SECAM
177	Rwanda	RRW	Africa	2.0	T	1	M	1_1	1_2	CTH	FRA	50	R	3	CAPTEF,FRATEL	FRA	EU	1.6	3.4	1	1	0	0	SECAM^
178	Saint Helena	SHN	Africa	15.9	T	1	G	1_1	ENG	PRT	ENG	x	L	2	None	UK	EU	x	x	x	0	0	0	PAL
179	Saint Kitts&Nevis	SCN	Americas	17.3	T	2	M	USA	ENG	PRT	ENG	60	L	2	CANTO,CITEL,CTO	USA	USA	12.1	23.7	1	0	0	0	NTSC
180	Saint Lucia	LCA	Americas	13.9	T	2	M	USA	ENG	CTH	ENG	50	L	2	CANTO,CITEL,CTO,FRATEL	USA	USA	9.1	65.7	1	0	0	0	NTSC
181	Saint Pierre&Miquelon	SPM	Americas	46.8	NT	2	F	1_1	FRA	CTH	FRA	50	R	2	None	FRA	EU	x	x	1	0	0	0	SECAM
182	Saint Vincent&the Gre	VCT	Americas	13.3	T	2	M	USA	ENG	PRT	ENG	50	L	2	CANTO,CITEL,CTO	USA	USA	52.9	73.6	1	0	0	0	NTSC
183	Samoa	SMO	Oceania	13.6	T	3	M	1_1	1_2	PRT	ENG	50	R	2	APT,CTO	UK	EU	5.8	13.4	1	0	0	0	PAL
184	San Marino	SMR	Europe	43.8	NT	1	M	1_1	ITA	CTH	FRA	50	R	2	CEPT	ITA	EU	62.6	x	1	0	0	0	PAL
185	Sao Tome&Principe	STP	Africa	1.0	T	1	M	1_1	POR	CTH	FRA	x	R	3	ATU,FRATEL	POR	EU	3.2	11.5	1	0	0	0	PAL
186	Saudi Arabia	ARS	Asia	25.0	NT	1	M	1_1	ARB	MSL	MS	60	R	2	ARBl,FRATEL	UK	ARB	32.1	78.1	1	1	1	1	SECAM^
187	Senegal	SEN	Africa	14.0	T	1	M	1_1	FRA	MSL	FRA	50	R	3	ATU,CAPTEF,ECOWAS,FRA	FRA	EU	5.6	25.0	1	0	0	0	SECAM
188	Serbia	SRB	Europe	44.0	NT	1	M	1_1	1_2	EST	DEU	50	R	2	CEPT	EEC	EU	33.8	63.3	1	0	0	0	PAL
189	Seychelles	SEY	Africa	43.8	T	1	M	1_1	ENG	CTH	ENG	50	L	2	CTO,FRATEL,TRASA	UK	EU	59.5	86.5	1	0	0	0	PAL
190	Sierra Leone	SRL	Africa	8.5	T	1	M	1_1	ENG	MSL	ENG	50	R	3	ATU,CTO,ECOWAS	UK	EU	2.3	2.2	1	0	0	0	PAL
191	Singapore	SNG	Asia	1.3	T	3	M	1_1	CHN	BDH	ENG	50	L	1	APT,CTO	UK	EU	82.9	109.3	1	0	1	1	PAL
192	Slovakia	SVK	Europe	48.7	NT	1	M	1_1	1_2	CTH	DEU	50	R	2	CEPT,EU	EEC	EU	68.4	90.6	1	0	0	1	PAL

	Country		Continent	Latitude	Tropic	Region	Sovereign	Dominant	Languag	Religion	Law	50/60	Side	Dev	Membership	20th	21st	2003	2006	GSM	CDMA	UMTS	TETRA	ColourTV
193	Slovenia	SVN	Europe	46.1	NT	1	M	1_1	1_2	CTH	RUS	50	R	1	CEPT,EU,FRATEL	EEC	EU	87.1	92.6	1	0	1	1	PAL
194	Solomon Islands	SLM	Oceania	8.0	T	3	M	1_1	1_2	PRT	ENG	x	L	3	CTO	UK	EU	0.3	1.3	1	0	0	1	PAL
195	Somalia	SOM	Africa	10.0	T	1	M	1_1	1_2	MSL	MS	50	R	3	ATU,ARBl	ARB	ARB	1.7	6.1	1	0	0	0	PAL
196	South Africa	AFS	Africa	29.0	NT	1	M	1_1	1_2	CTH	ENG	50	L	2	ATU,CTO,TRASA	UK	EU	36.4	83.3	1	0	1	1	PAL
197	Spain	E	Europe	40.0	NT	1	M	1_1	SPA	CTH	FRA	50	R	1	CEPT,EU	UK	EU	87.2	106.4	1	0	1	1	PAL
198	Sri Lanka	CLN	Asia	7.0	T	3	M	1_1	1_2	BDH	ENG	50	L	2	APT,CTO	UK	APT	7.2	25.9	1	1	0	0	PAL
199	Sudan	SDN	Africa	15.0	T	1	M	1_1	ARB	MSL	ENG	50	R	3	ATU,ARBl	ARB	ARB	1.6	12.7	1	0	0	1	PAL
200	Suriname	SUR	Americas	4.0	T	2	M	1_1	NLD	HND	FRA	60	L	2	CANTO,CITEL,IIRSA	USA	USA	35.0	70.8	1	0	0	0	NTSC
201	Swaziland	SWZ	Africa	26.5	NT	1	M	1_1	ENG	1_2	ENG	50	L	2	ATU,CTO,TRASA	UK	EU	8.1	24.3	1	0	0	0	PAL
202	Sweden	S	Europe	62.0	NT	1	M	1_1	1_2	PRT	NRD	50	R	1	CEPT,EU	UK	EU	98.0	105.9	1	1	1	1	PAL
203	Switzerland	SUI	Europe	47.0	NT	1	M	1_1	DEU	PRT	DEU	50	R	1	CEPT,EFTA,FRATEL	DEU	EU	84.6	102.1	1	0	1	1	PAL
204	Syria	SYR	Asia	35.0	NT	1	M	1_1	ARB	MSL	FRA	50	R	2	ARBl	FRA	EU	6.8	24.0	1	0	0	1	PAL
205	Taiwan	TWN	Asia	23.5	NT	3	CHN	1_1	CHN	BDH	DEU	60	R	1	None	USA	USA	114.1	102.0	1	1	1	1	NTSC
206	Tajikistan	TJK	Asia	39.0	NT	1	M	1_1	RUS	MSL	RUS	50	R	2	RCC,USSR	RUS	RUS	0.7	4.1	1	1	1	0	SECAM
207	Tanzania	TZA	Africa	6.0	T	1	M	1_1	1_2	MSL	ENG	50	L	3	ATU,CTO,TRASA	UK	EU	2.9	14.8	1	0	0	0	PAL
208	Thailand	THA	Asia	15.0	T	3	M	1_1	1_2	BDH	ENG	50	L	2	APT	UK	APT	40.1	63.0	1	1	1	1	PAL
209	Togo	TGO	Africa	8.0	T	1	M	1_1	FRA	1_2	FRA	50	R	3	ATU,CAPTEF,FRATEL,ECOW	FRA	EU	4.4	11.2	1	0	0	0	SECAM
210	Tokelau	TKL	Oceania	9.0	T	3	NZL	1_1	1_2	PRT	ENG	x	L	2	None	UK	OCN	x	x	x	0	0	0	No TV
211	Tonga	TON	Oceania	20.0	T	3	M	1_1	1_2	PRT	ENG	50	L	2	APT,CTO	UK	EU	11.3	29.8	1	0	0	0	PAL
212	Trinidad&Tobago	TRD	Americas	11.0	T	2	M	USA	ENG	CTH	ENG	60	L	2	CANTO,CITEL,CTO	USA	USA	37.3	126.4	1	1	0	1	NTSC
213	Tunisia	TUN	Africa	34.0	NT	1	M	1_1	ARB	MSL	FRA	50	R	2	ATU,ARBl,CAPTEF,FRATEL	FRA	EU	19.4	71.9	1	0	0	1	SECAM
214	Turkey	TUR	Europe	39.0	NT	1	M	1_1	1_2	MSL	FRA	50	R	2	CEPT	EEC	EU	39.4	71.0	1	0	0	1	PAL
215	Turkmenistan	TKM	Asia	40.0	NT	1	M	1_1	RUS	MSL	RUS	50	R	2	RCC,USSR	RUS	RUS	0.2	2.2	1	0	0	1	SECAM
216	Turks&Caicos Islan	TCA	Americas	21.8	T	2	G	USA	ENG	PRT	ENG	x	L	2	CANTO	USA	USA	x	x	1	0	0	0	NTSC
217	Tuvalu	TUV	Oceania	8.0	T	3	M	1_1	1_2	PRT	x	x	L	3	CTO	UK	EU	x	12.4	0	0	0	0	PAL
218	Uganda	UGA	Africa	1.0	T	1	M	1_1	ENG	PRT	ENG	50	L	2	ATU,CTO	UK	EU	3.0	6.7	1	1	0	0	PAL
219	Ukraine	UKR	Europe	49.0	NT	1	M	1_1	RUS	EST	RUS	50	R	2	CEPT,RCC,USSR	RUS	RUS	13.6	106.7	1	1	0	0	SECAM^
220	United Arab Emir	UAE	Asia	24.0	NT	1	M	1_1	ARB	MSL	ENG	50	R	1	ARBl	UK	ARB	73.6	118.5	1	0	1	1	PAL

	Country		Continent	Latitude	Tropic	Region	Sovereign	Dominant	Languag	Religion	Law	50/60	Side	Dev	Membership	20th	21st	2003	2006	GSM	CDMA	UMTS	TETRA	ColourTV
221	United Kingdom	G	Europe	54.0	NT	1	M	1_1	ENG	PRT	ENG	50	L	1	CEPT,CTO,EU	UK	EU	91.4	116.4	1	0	1	1	PAL
222	United States	USA	Americas	38.0	NT	2	M	USA	ENG	PRT	ENG	60	R	1	CITEL,NAFTA	USA	USA	54.6	77.4	1	1	1	0	NTSC
223	Uruguay	URG	Americas	33.0	NT	2	M	1_1	SPA	CTH	FRA	50	R	2	CITEL,IIRSA,Mercosur,REGU	USAl	USAl	15.4	66.8	1	1	0	0	PAL
224	Uzbekistan	UZB	Asia	41.0	NT	1	M	1_1	RUS	MSL	RUS	50	R	2	RCC,USSR	RUS	RUS	1.3	2.7	1	1	0	0	SECAM
225	Vanuatu	VUT	Oceania	16.0	T	3	M	1_1	ENG	PRT	ENG	x	R	3	CTO,FRATEL	UK	EU	3.8	5.9	1	0	0	0	PAL
226	Vatican City	CVA	Europe	41.9	NT	1	M	1_1	ITA	CTH	FRA	50	R	1	CEPT	ITA	EU	x	x	1	0	1	1	PAL
227	Venezuela	VEN	Americas	8.0	T	2	M	1_1	SPA	CTH	FRA	60	R	2	CITEL,IIRSA,REGULATEL	USAl	USAl	27.3	69.0	1	1	0	1	NTSC
228	Vietnam	VTN	Asia	16.0	T	3	M	1_1	1_2	BDH	RUS	50	R	2	APT,FRATEL+S32	FRA	EU	3.4	18.2	1	1	0	1	SECAM
229	Virgin Islands (U.	VIR	Americas	18.3	T	2	USA	USA	ENG	PRT	ENG	60	L	2	CANTO	USA	USA	44.5	71.7	1	1	0	0	NTSC
230	Wallis and Futuna	WAL	Oceania	13.3	T	3	F	1_1	FRA	CTH	FRA	50	R	2	None	FRA	EU	x	x	x	0	0	0	SECAM
231	West Bank & Gaza	WBG	Asia	32.0	NT	1	PSE	an ITU Note	ARB	MSL	MS	50	R	2	ARBl	UK	EU	13.3	x	1	0	0	0	PAL
232	Western Sahara	AOE	Africa	24.5	NT	1	AOE	x	ARB	MSL	x	x	R	3	None	ARB	ARB	5.8	x	0	0	0	0	No TV
233	Yemen	YEM	Asia	15.0	T	1	M	1_1	ARB	MSL	ENG	50	R	3	ARBl	UK	ARB	3.5	9.5	1	1	0	0	PAL
234	Zambia	ZMB	Africa	15.0	T	1	M	1_1	ENG	PRT	ENG	50	L	3	ATU,CTO,TRASA	UK	EU	2.2	14.0	1	1	0	0	PAL
235	Zimbabwe	ZWE	Africa	20.0	T	1	M	1_1	ENG	1_2	ENG	50	L	2	ATU,TRASA	UK	EU	3.1	6.4	1	0	0	0	PAL